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The bids for the construction of the new Croton dam on the Cornell site were opened June 29 by the Aqueduct Commissioners, New York, and the detail prices are given in another column. The bidders and totals Baltimore, Md., $3,527,640; H. H. Brown, New York, $4,181,464; M. S. Coleman, New York, $4,298,495; Winston, Crimmins, Washburne & Co., New York, $4,765,449; McQuade & Moore, New York, $5,200,774; Wm. Russell, Allen & Co., St. Louis, Mo., $5,549,908. The engineer's estimate was $4,574,820, and the highest and lowest bids were approximately $1,000,000 above and below this estimate respectively.

A dam 40 ft. high, 900 ft. long and 166 ft. through at the base, it is reported, will be built for the Genesee Rag & Paper Co., at Gibsonville, N. Y. The dam will give additional water storage.

The construction of a 20,000,000-gallon filtering plant for Philadelphia has been authorized. The general conditions with which the filtering plant must comply are as follows: 1. The bed shall not be less than 4 ft. in depth and may be composed of sharp sea sand, sea sand and coke or prepared quartz. (2) The maximum rate of filtration will be 2½ gallons to 1 sq. ft. of filtering surface per hour. (3) Not more than 3% of filtered water shall be required in washing the plant. (4) All odor, color, and impurities in suspension must be removed from the water; the albuminoid ammonia in the filtered water must not exceed 0.10 part per million, nor free ammonia 0.015; the number of colonies of microbes in the filtered water must not exceed 100 per cu. cm.; none of the coagulent or other purifying agent shall be left in the water.

A tunnel two miles in length is to be built to connect the concentrators of the Bunker Hill and Sullivan mining companies, situated on the South Fork of the Coeur d'Alene River, with their mines near Wardner, Idaho. The present system for transporting the ores to the concentrators is becoming inadequate. It is stated that the line of the tunnel has been located and that work will be begun at once, the air compressors and other machinery having already been ordered. There will be one shaft and the excavation will be carried on from three headings. The tunnel will strike the company's ore veins about 2,000 ft. below the present workings.

The Busk tunnel through the Continental Divide on the Colorado Midland Ry., has been driven 2,300 ft. on the Busk end and 2,700 ft. on the Ivanhoe end, a total distance of 5,000 ft. The total length of the tunnel is 9,350 ft., which leaves 4,350 ft. to be driven. The progress of the work for the past month has been about 10 ft. per day. The material penetrated is granite and porphyry intersected by small seams of decomposed granite and talc.

The attendance at the Columbian Exposition, even now, according to the last bulletin issued by the Publication Department, ranges from 5,000 to 12,000 tickets daily at 25 cts. each, though the only thing to see is the grounds and the now nearly completed buildings. Aside from the great general interest in the fair which this indicates, such sales will make a substantial addition to the treasury before the gates to the exhibition proper are opened, as it means from $1,250 to $3,000 per day addition to the funds.

The most serious railway accident of the week was the derailment of a mixed train by a washed out 4-ft. stone box culvert July 2, near Keller's, Ind., on the Wabash R. R. The engine and nine cars went down and five men on the engine were killed, including Mr. H. Dunlap, Superintendent of Bridges.—Another serious railway accident was the derailment of an excursion train on the Louisville Southern R. R., about 20 miles from Louisville, Ky., July 4. The engine and cars (except the baggage car) went down a 15-ft. bank, but only one man was killed and eleven were injured. The wreck caught fire and the cars were destroyed.

The sliding of a bank of earth caused the death of four workmen who were engaged in laying the abutment of a new bridge on Broad St., Providence, R. I., on June 30. As soon as the slide occurred the rescue of the buried men was attempted. The head of one who was living had been uncovered when a 10-in. water pipe burst just overhead and filled the excavation with water. The site of this accident is reported to be only a hundred yards from the spot where the trench of the Providence sewer caved in about a year ago, killing several workmen.

A sewer trench at Binghamton, N. Y., caved in June 24, killing two men. The trench was in wet earth, and was seven or eight ft. deep. The plank siding had not been extended to the place where the accident occurred.

A serious flood has caused considerable damage in the neighborhood of Grand Crossing, Ill. The 87th St. dike is said to have been cut maliciously, letting in the water from the lake and covering about five square miles with water from two to eight feet deep.

The Chicago & South Side Elevated Ry. Co. has now acquired the right-of-way from Congress St. to Jackson Park. The foundations for the line south of 40th St. have been nearly completed and the line will soon be put into operation to 41st St. The metal work has been ordered from the Keystone Bridge Co. for the line through to Jackson Park.

The new dam across the Colorado River at Austin, Tex., will raise the river 60 ft. above its low water mark. Mr. J. T. Fanning, Mem. Am. Soc. C. E., and Consulting Engineer for the city of Austin, states that the river above the dam has a drainage area of 40,000 square miles, and that in times of flood from 200,000 to 250,000 cu. ft. of water per second will pass over the crest of the dam. No dam in existence, Mr. Fanning states, in a recent report to the Austin Board of Public Works, has to pass a volume of flood water, over so great a height, which approximates to the above. Mr. Fanning recommends a change in the section of the dam in order to avoid the sheer fall of the water. The dam is being built by the city of Austin to develop power to operate its water and electric lighting plants, and for manufacturing purposes. The dam will be 70 ft. high and 1,125 ft. long and will set back water for some 25 miles. It is being built of masonry, and was described and illustrated in Engineering News of July 11, 1891. The suspension cableway used in its construction was described and illustrated in Engineering News of Nov. 14, 1891.

A magnesium flash light for lighthouses is to be tried at Staten Island by the U. S. Lighthouse Department. The light is the invention of Prof. J. C. Schirm, of Berlin, Germany, and has been tested at Hamburg, where, it is said, it was visible for six miles with the sun shining. The apparatus is 6.56 high and 3 ft. diameter. Inside is a bellows through which benzine gas is led, while air is forced through pumice stone, strongly impregnated with benzine. This benzine gas is then passed through finely powdered magnesium, and passes out of an upright pipe through a small flame, by which it is lighted, and where it develops such an intensity that the apparatus shows a luminosity of about 400,000 c. p. The apparatus is regulated by clockwork. The consumption of magnesium is very small. If a power of 200,000 to 400,000 c. p. is desired, only 0.6 to 1.5 grains of magnesium powder are required. The consumption is from 22 to 55 grains in ten hours, representing a cost of $1.50 to $2.50. The apparatus is not necessarily used with condensers or other optical arrangements or reflectors; if, however, lenses be used the brilliancy is greatly increased. The great advantage with this light is its ability to penetrate almost opaque atmosphere to a greater extent than any other light hitherto produced. This is a property that is almost lacking in the electric light.

It is estimated that a light of about 80,000 c. p., producing six flashes per minute, would cost $1.68 for ten hours' maintenance. The apparatus itself, which requires a floor service of 5 ft. square, would cost $1,250. Observations on apparatus set up at Bremen, Bremerhaven, and Hamburg, are said to have verified the strength of the light and its power to penetrate very heavy fogs. The light at Bremen was observed for 70 miles and gave the appearance of lightning on the northern horizon. The observer could give exactly the intervals at which the flashes followed each other.

A railway route from Vladikavkas to Tiflis has been surveyed by engineers of the Russian Government, and the plans have been submitted to the Minister of Communications. It is proposed to construct the line north of the Caucasus ridge, through the Valley of Terek, in the main following the existing military road, and to join the Poti-Baku Ry. in the vicinity of Tiflis. This would necessitate the boring of a tunnel equal in length to that of Mont Cenis. The cost of the line would be enormous, but its strategical importance equally great. By road the journey now takes about a week, whereas by rail it would be accomplished in seven hours. The line would also be of immense consequence in an attack on India, as Russia would be able in a few hours to transport an army corps right to Baku, where the Caspian fleet would convey it to Michailowsk, the western terminus of the Transcaspian Ry., by which it would be conveyed to Sanaks, and thence in a few days to Herat. The line would also be of great service in operations against Persia. At present a railway is under construction from Vladikavkas to Petrovsk on the Caspian Sea, and will soon be finished. It is intended to continue this line to Baku, where there are no engineering difficulties, and when this line is completed it will be possible to reach Baku just as quickly as through the Caucasus and via the Transcaspian Railway. Since 1888 Vladikavkas has been connected with the Black Sea by the branch line from Tichoretskaja to the port of Novorossiisk, which latter place has in consequence risen from a fishing village to one of the largest grain depots in the empire. However, the railway through the Darjal Pass would enable an army to reach Tiflis and Kars 18 hours quicker than via Petrovsk and Baku, but, as stated, the cost of such a line would be very heavy. This railway was referred to in our issue of March 14, 1891.

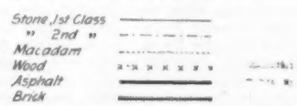
A tunnel under 34th St., New York City, from the East to the North River, is proposed by the New York & Queens County R. R. Co. A franchise for its construction was asked of the Board of Aldermen on July 5. The Committee on Bridges and Tunnels will hear arguments for and against the granting of the franchise on July 11, at 1 p. m.

A survey for the proposed Philadelphia & New York ship canal is authorized by a bill just introduced in the Senate.

STREET PAVEMENTS IN AMERICAN CITIES.

The bad pavements of American cities have furnished texts for a great many sermons both good and bad. It must be admitted that pavements in American cities are generally bad, although they are rapidly becoming better. Their badness is not wholly, however, on account of original and intrinsic defects, but more often because of neglect. The factors which enter into the requisites for a good pavement are in a great degree contradictory, and no one material has yet been found which possesses all of them. This has brought about a differentiation of the several kinds of paving materials into classes varying according to the character and intensity of the traffic which they are to bear. For each class of traffic that material is selected which possesses the greatest number of desirable factors. In European cities the behavior of several of the more common kinds of paving material under varying conditions has been quite carefully recorded, and important data have been secured in regard to the durability, cost of construction and maintenance, comparative safety, etc. Street paving in Europe is consequently approaching a standard practice in so far as the varying conditions of locality and the character of the material obtainable will permit. It is only within a few years, however, that these matters have received any attention in this country, and this only in a few cities. In a great majority of cities durability and first cost have been, and are yet to a considerable extent, the ruling factors in the selection of a paving material. This has resulted in the laying of large quantities of cobblestone and rubblestone pavement, many miles of which yet remain in some of our larger cities. The value of our experience is, therefore, not so high as it should be.

In a paper recently read before the Commercial Club, of Kansas City, Mo., Mr. Robert Gillham, M. Am. Soc. C. E., has collected statistics of street paving from about 50 American cities. From these figures, with some additions from our own records, we have compiled the accompanying tables and diagrams. The figures are by far the most complete record of this kind ever published, and, while lacking in many details of construction and maintenance, are of great interest as showing the general tendency of practice, and Mr. Gillham deserves great credit for his faithful labor in collecting them. In order to make the vast amount of information in his tables still more useful, however, we have radically reconstructed most of them, and prepared new diagrams.



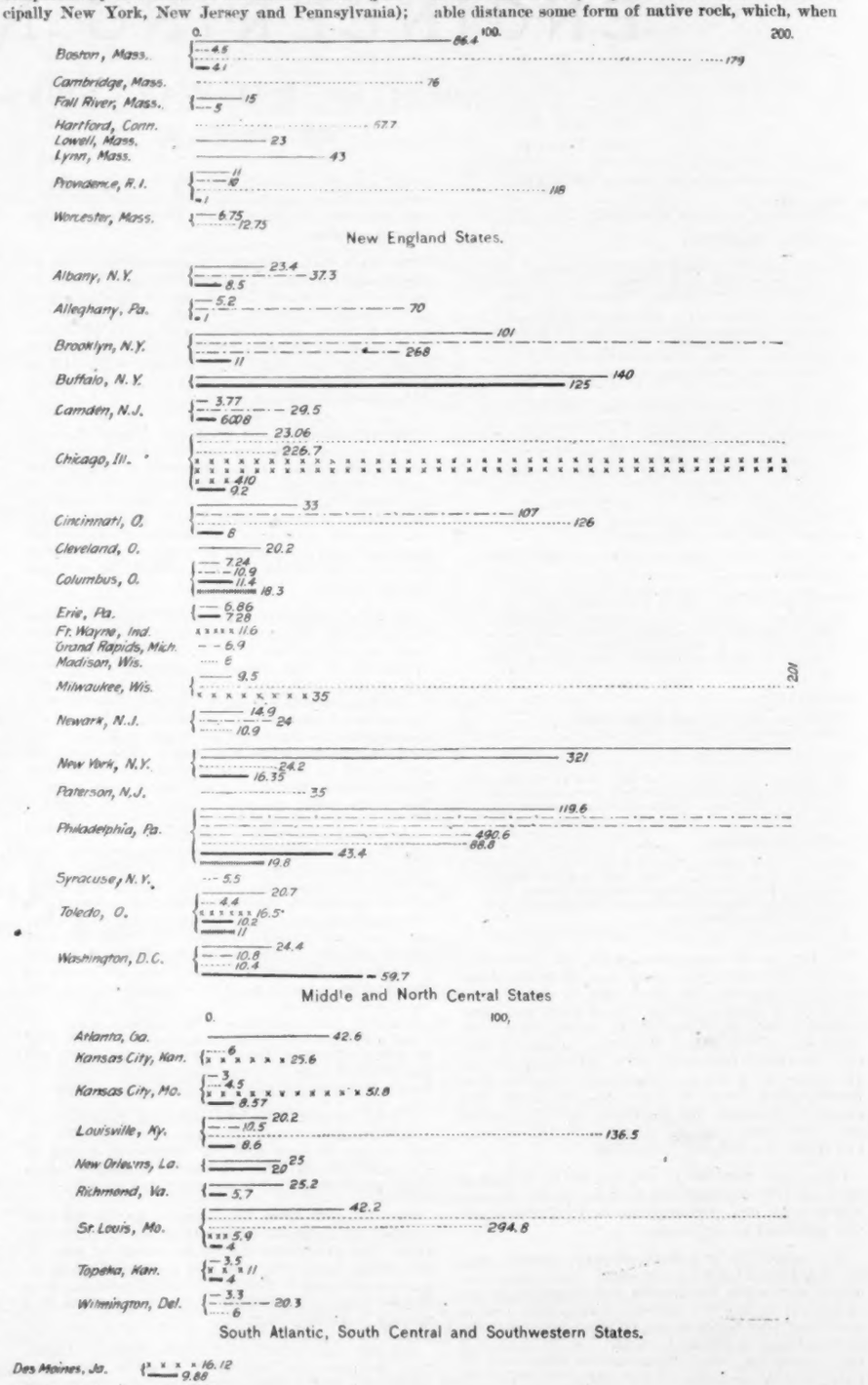
Key to Symbols Used in Diagrams.

The four most common paving materials in the order of the extent used are stone, macadam, wood, asphalt and brick, as shown in Tables 1 and 2. In addition to these, gravel, concrete, bituminous rock, shells and slag, plank and various kinds of artificial stone are used to a limited extent. The character and extent of these pavements are shown in Table 3. Stone pavements are divided into two classes: (1) Dressed stone blocks or sets of regular dimensions, generally granite, sandstone and trap rock, and (2) cobblestone, or boulder; rubblestone, and undressed irregular blocks.

The standard paving material for the majority of cities in the New England, Middle, North Central, Southern and Southwestern states is dressed stone blocks for all streets having heavy traffic. Granite is the stone most commonly used, especially in the New England, Middle and Southern States. In the North Central and Southwestern states sandstone is quite commonly used, and limestone is used to a limited extent in a few cities. With the exception of the Belgian blocks, the general dimensions of stone blocks from 3½ to 4 ins. in width, from 10 to 15 ins. in length, and from 7 to 10 ins. in depth. The foundations most commonly used are sand, gravel and crushed stone. Concrete on a gravel or crushed stone base is used in several cities on some of the more important streets.

Both cobblestone and rubblestone pavements are relics of a former and more barbarous age in street paving. Very little of this pavement is now being laid in cities of any size. Its use is confined to a comparatively few cities in the Middle states (principally New York, New Jersey and Pennsylvania); Brooklyn, N. Y., and Philadelphia, Pa., being the principal offenders. The almost total lack in cobblestone and rubble pavements of any of the requisites of a good pavement, except durability and cheapness, will exclude any great use of them.

Next to stone, macadam is used in excess of all other kinds of paving material. The reason for this is that almost every city can secure within a reasonable distance some form of native rock, which, when properly laid, forms a satisfactory subgrade and wearing surface and a durable street, at a low first cost. A very considerable proportion of this class of pavement in most cities is anything but macadam in the proper sense of that term, however. Its use



MILEAGE OF DIFFERENT CLASSES OF PAVEMENT IN USE IN 52 CITIES OF THE UNITED STATES.

is confined to suburban streets and streets used for pleasure driving, and when well constructed and maintained is superior to most other kinds of pavement for this class of streets.

Wood and brick pavements are quite extensively used in many of our western cities. For wood pavements cedar blocks are generally used, although cypress and pine blocks have been laid in a few cities. The general concensus of opinion seems to be that while this pavement has served a purpose in meeting the conditions imposed by the rapid growth of some of our western cities, it should be replaced by some better material. Even when laid on a good concrete foundation, which is the exception, it has not proved satisfactory. The reason for this is largely due to the use of unseasoned wood, poor foundations and generally poor construction, and an almost total lack of anything like proper care and maintenance. Wood block pavements can hardly be said to have been given a proper trial in this country. There seems to be a tendency in some of the cities in the Northwestern states to replace wood blocks with brick as fast as possible. Notwithstanding all that has been written about brick for pavements, however, its use is thus far largely experimental. Many small towns and cities have laid brick, and some of the outlying streets in a few of the larger cities have been paved with it. None of the cities using brick pavement give any records of the cost of maintenance. The general opinion seems to be that too little regard is paid to the character of the bricks used, but that properly vitrified bricks furnish a very desirable material for certain classes of streets. A very complete article on the use of brick pavements in this country will be found in our issues of July 19 and 26, 1890.

Asphalt, or more properly a mastic of bitumen and limestone or sand, the limestone and sand being used to give a harder wearing surface, is used to a greater or less extent for pavements in a large majority of the cities included in the tables. The cities of Buffalo, N. Y., and Washington, D. C., especially, have a large percentage of this pavement. In San Francisco, Cal., and a few other cities on the Pacific coast bituminous sandstone is largely used. This pavement corresponds quite closely in character and construction to the bituminous limestone and sand stone pavements used in Paris and other European cities, and there known as asphalt pavements.

Only about one half of the cities included in Tables 1 and 2 give any records of the average life of the several kinds of pavements used, and a very much smaller number report the cost of maintenance. These are shown in Tables 4 and 5 respectively. The average length of life of all kinds is generally less than in European cities, as will be seen by comparing Table 4 with Table 6, where we have shown the average life of pavements as reported from seven of the larger European cities. In making this comparison, however, it is to be borne in mind that pavements in this country can attain a much poorer condition before being considered worn out than they can in Europe. The cost of maintaining granite block, asphalt and macadam pavements in cents per square yard per year in five cities is shown in Table 5. A few other cities report costs of maintenance in isolated cases, but as these reports are too heterogeneous to be conveniently classified, we have not included them in the table. In Table 7 we give a similar table of costs for maintenance in the seven European cities before noted. Any comparisons of costs between these two tables are of little value owing to the generally lower standard of maintenance in this country.

In Table 2 the character of the foundation and the costs of the several kinds of pavements are quite fully shown. This table needs no discussion in addition to the notes appended to it. As before stated, these various tables are of interest principally as showing the general tendency of practice in street paving in the United States. Studied in this light they are full of instruction. The following general considerations affecting the subject of street paving in this country are abstracted from the conclusion of Mr. Gillham's paper:

All streets to any extent occupied with dwellings or other houses within the limits of any city should be paved. Any community that makes pretensions, or claims the dignity of a city, should be prepared to fully exercise every influence to bring about the highest possible standard of finished public work, and not pave a portion of a street, leaving the balance dust spaces or mud roads. It does not speak well for the municipal authorities or the citizens of any community, to carry out public works indifferently. Works should not be undertaken without having, in all departments, given the fullest consideration to every detail entering into proposed works. Even while almost all Western cities have had to contend with the development of new areas in order to accommodate most wonderful gains in population, this fact does not altogether excuse the lack of thorough and comprehensive systems for street improvements, for sewerage, for laying out of additions, for buildings, for parks and boulevards, for sanitation, for regulation of street traffic, etc.

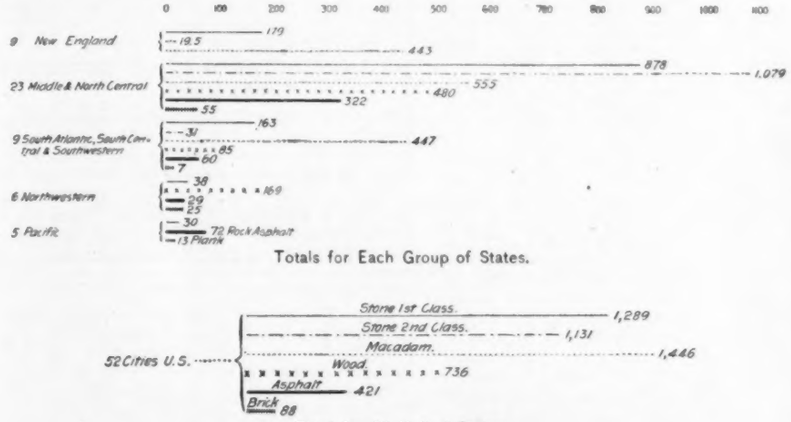
Political issues should not defeat necessary and permanent city improvements of utility. All political parties should be equally equipped for an intelligent administration of public affairs. This adds strength to party organization. Parties in power should be slow to act on any measures contemplating the expenditure of public funds, without first securing the best possible information, reliable advice and safe counsel relating to the works contemplated. The Board of Public Works is an important auxiliary to the legislative departments of a city. The character, nature and utility of public improvements rest largely with it.

Cities should not be too anxious, for the purpose of augmenting population, to take in additional territory and outlying additions, for the reason that large areas of unimproved city property tend to retard desirable local improvements. In the matter of additions, the plan adopted by some of the continental cities would operate very satisfactorily in many cities in this country. No addition of new city lots is approved until the street is paved, water and gas pipes laid, with connections to every lot, sewers built with sewer connections to each lot, trees planted and curbing and sidewalks placed. This plan would perhaps limit the number of additions, but uniform street improvements would be the result.

When the position is taken that streets more or less occupied with dwellings or other buildings in the city should be paved, it is not intended as a suggestion to pave all streets regardless of the nature of the traffic and actual requirements. Individual property interests should not interfere with the improvement of streets. If property is damaged, the law should provide for just compensation. Public interest and the general public good is higher than individual property interests. The fact that an addition has been laid out, and by the authority of the city, streets established and dedicated to public use, and as a result houses from time to time built, ought to insure proper and desirable access, not only for the owners and dwellers on the streets, but also for the public. Public necessity may not be great for the improvement of local and unimportant streets, but the fact that they are used, makes the improvement of them necessary.

Uniform pavements should be adopted and established for all streets. The following pavements are recommended: For streets having a heavy traffic, dressed granite or Medina sandstone blocks; for retail streets and principal streets and avenues, asphalt, and for drives, boulevards and side streets, and streets somewhat remote and not main thoroughfare, macadam.

The last can be laid at an elevation below the regular grade of the street, so that as traffic increases and it becomes necessary to lay asphalt or stone, the macadam roadway may be used as the foundation for the new pavement. If vitrified bricks prove durable and can be made uniform in quality, as is promised,



MILEAGE OF DIFFERENT CLASSES OF PAVEMENT IN USE IN THE UNITED STATES.

(For key to symbols, see page 2.)

TABLE 1.

Mileage of Stone, Macadam, Wood, Brick and Asphalt Pavements in 51 American cities.

	Stone 1st.	Stone 2d.	Macadam.	Wood.	Asph't.	Brick
New England States.						
Boston, Mass.	86.4	4.5	179.	....	4.1	0.2
Cambridge, Mass.	2.5		76.	....	....	....
Fall River, Mass.	15.	5.	....	....	....	....
Hartford, Conn.	....	....	57.7	....	....	....
Lowell, Mass.	24.	....	....	....	....	....
Lynn, Mass.	43.	....	....	....	....	....
Providence, R. I.	11.	10.	118.	....	0.8	0.03
Springfield, Mass.	1.4	....	....	....	....	....
Worcester, Mass.	6.75	....	12.75	....	....	....
Total	177.	19.5	443.5	....	4.9	0.23
Per cent. of total	27.7	3.01	68.6	....	0.7	....
Middle and North Central States.						
Albany, N. Y.	23.4	37.3	2.2	....	8.5	....
Allegheny, Pa.	5.2	70.	....	....	0.9	0.2
Brooklyn, N. Y.	101.	268.	....	....	11.	....
Buffalo, N. Y.	140.	....	....	....	125.	....
Camden, N. J.	3.77	29.5	0.61	....	6.08	0.01
Chicago, Ill.	23.06	....	226.7	410.	9.2	0.33
Cincinnati, O.	33.	107.	126.	2.	8.	2.
Cleveland, O.	20.2	....	2.	1.5	0.4	2.2
Columbus, O.	7.24	10.94	....	....	11.43	18.26
Dayton, O.	1.17	....	....	....	0 09	0.88
Erie, Pa.	6.86	....	....	....	7.28	....
Ft. Wayne, Ind.	....	....	1.4	11.6	1.7	0.5
Grand Rapids, Mich.	....	6.91	....	2.76	0.22	....
Madison, Wis.	....	....	6.	....	....	....
Milwaukee, Wis.	9.5	....	201.	35.	....	....
Newark, N. J.	14.89	24.12	10.87	....	1.34	....
New York, N. Y.	321.3	3.32	24.24	0.03	16 35	....
Paterson, N. J.	3.5	1.5	35.5	....	....	....
Philadelphia, Pa.	119.6	490.6	88.8	....	43.4	19.8
Syracuse, N. Y.	....	5.52	0.44	....	1.91	1.32
Toledo, O.	20.7	4.4	....	16.5	10.2	11.
Washington, D. C.	24.5	10.8	10.4	....	59.7	....
Total	878.9	1,079.	555.	480.	322.7	55.5
Per cent. of total	26.2	32.2	16.6	14.4	9.8	1.7
South Atlantic, South Central and Southwestern States.						
Atlanta, Ga.	42.6	....	....	....	....	....
Kansas City, Kan.	0.2	....	6.	25.6	1.5	0.5
Kansas City, Mo.	3.03	....	4.51	51.87	8.57	1.81
Louisville, Ky.	20.2	10.5	136.5	....	8.6	0.3
New Orleans, La.	25.	....	....	....	20.	....
Richmond, Va.	25.2	....	....	....	5.7	....
St. Louis, Mo.	42.72	....	294.8	5.91	3.95	....
Topeka, Kan.	3.5	....	....	2.1	11.	4.
Wilmington, Del.	3.3	20.3	6.	....	0.5	0.3
Total	162.75	30.8	447.8	85.48	59.82	6.91
Per cent. of total	20.5	3.83	56.6	10.7	7.5	0.87
Northwestern States.						
Des Moines, Ia.	....	....	....	16.12	....	9.88
Lincoln, Neb.	0 6	....	....	12.3	....	11.7
Minneapolis, Minn.	4.	....	....	31.5	1.3	....
Omaha, Neb.	33.	....	....	37.8	24.7	....
St. Paul, Minn.	0.3	....	....	43.4	5.1	0.3
Sioux City, Ia.	....	....	....	28.4	....	0.3
Total	37.9	....	....	169.5	29.1	25.18
Per cent of total	14.45	....	....	64.8	11.13	9.62
Pacific States.						
Denver, Colo.	0.9	....	....	....	3.8	....
Portland, Ore.	5.3	2.	....	0.4	0.3	....
Salt Lake City, U.	0.3	....	....	....	0.1	....
San Francisco, Cal.	24.	....	....	....	....	....
Tacoma, Wash.	....	....	....	0.1	....	....
Total	30.5	2.	....	0.5	4.2	....
Per cent. of total	83 3	5.36	....	0 14	11.3	....
Grand total, 51 cities	1,289	1,113	1,446	736.	421.	87 8
Per cent. of total	25.3	22.1	28.3	14.4	8.2	1.7

TABLE 2.

Cost per Square Yard and Character of Foundation of Stone, Asphalt, Brick, Wood and Macadam Pavements in 55 American Cities, together with the Per Cent. of each kind.

N. B.—The capital letters denote the material used for foundation. S = sand; G = gravel; C = concrete; M = macadam; E = earth; P = plank.

City.	Population, 1890.	Miles of pavement.	Stone Block. P. C. of total.	Stone Block. Cost per sq. yd.	Cobble & Rubble. P. C. of total.	Cobble & Rubble. Cost per sq. yd.	Sheet Asphalt. P. C. of total.	Sheet Asphalt. Cost per sq. yd.	Brick. P. C. of total.	Brick. Cost per sq. yd.	Wood. P. C. of total.	Wood. Cost per sq. yd.	Macadam. P. C. of total.	Macadam. Cost per sq. yd.
NEW ENGLAND STATES.														
Boston, Mass.	448,477	308.6	C. & G. (a) 15.94	$3.90	1.37	.....	C. (0.11)* 0.96	$(3.10) 3.50	0.2	.....	.....	.....	47.	.....
Cambridge, Mass.	70,028	78.5	G. (a) 3	2.50	.....	.....	.....	.....	.....	.....	.....	.....	97.	$1.60
Fall River, Mass.	74,398	20.	G. & M.(a)	2.50	G.& M.	$1.25	.....	.....	.....	.....	.....	.....	.....	.....
Hartford, Conn.	53,230	57.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.	1.00
Lowell, Mass.	77,696	23	100 S.	2.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lynn, Mass.	55,727	43	100 G.	2.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Providence, R. I.	132,146	130.8	C. (a) 7.8	3.70	7.1	1.00	C. 0.5	2.65	C. 0.01	$2.14	.....	.....	84.5	.....
Springfield, Mass.	44,179	1.4	S. (a) 100	2.07	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Worcester, Mass.	84,655	19.5	G. (a) 34.6	2.40	.....	.....	.....	.....	.....	.....	.....	.....	65.4	0.40
MIDDLE AND NORTH CENTRAL STATES.														
Albany, N. Y.	94,923	71.4	S. 33.6 (b)	$2.67	51.7	$1.10	C. 117	$3.13	.....	.....	.....	.....	3.	$1.25
Allegheny, Pa.	105,287	76.3	G. 6.8	3.00	G. 91.8	1.10	G. (0.9)* C. 0.2	2.75) 3.85	0.2	.....	.....	.....	.....	.....
Baltimore, Md	434 433	.....	.....	2.90 (c)	.....	.....	M.	2.70	.....	$1.80	.....	.....	.....	.....
Brooklyn, N. Y.	806,347	380.	G. 26.5 (d)	.....	70.5	0.75	G. & S. 2.9	3.00	.....	.....	.....	.....	.....	.....
Buffalo, N. Y.	255,664	265.	C. & S. 50	2.75 to 3.10	.....	.....	C. 50	3.60	.....	.....	.....	.....	.....	.....
Camden, N. J.	58,313	40.	9.4 (e)	2.00	73.7 (f)	0.79 to 0.94	15.2	1.87	0.3	.....	.....	.....	1.5	.....
Chicago, Ill.	1,099,850	669.6	M. 3.45 (a)	3.05	.....	.....	C. 1.38	2.90	S. 0.5	2.00	M. & W. 61.3	1.00	33.8	1.19
Cincinnati, O.	296,908	278.	C. 16. (g)	5.00	M. 31.	4.00	C. 3	3.00	C. 0.8	4.00	0.8	.....	45	3.00
Cleveland, O	261,353	26.2	E. 76.4	1.80 to 2.97	.....	.....	C.0.2	2.25	E. 8.4	1.35	5.7	.....	7.7	.....
Columbus, O.	88,150	124.9	M. 5.7	3.71	8.7	.....	C. 9.1	2.54	M. 14.5	1.94	.....	.....	.....	.....
Dayton, O.	61,220	3.1	C. 38. (h)	3.47 to 3.73	.....	.....	C. 27 (3,)*	(3.32) 2.32	.....	.....	.....	.....	.....	.....
Detroit, Mich.	205,876	140.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Erie, Pa.	40,634	14.1	G. 53.(i)	2.30	.....	.....	C.47	2.98	.....	.....	.....	.....	.....	.....
Ft. Wayne, Ind	35,392	15.2	.....	.....	.....	.....	M. 11.2	2.64	M. 3.3	1.60	M. 76.3	1.21	9.2	.....
Gnd. Rapids, Mich.	60,278	104.	.....	.....	S. &. G. 6.6	.....	C. 0.2	2.65	.....	.....	M. P. & C. 2.6	1.50	.....	1.35
Madison, Wis.	13,426	6.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	.....
Milwaukee, Wis.	204,468	245.5	G. 3.9	2.45	.....	.....	.....	.....	.....	.....	G. 14.3	1.10	81.8	.....
Newark, N. J.	181,830	51.2	S. 29.6	2 07 to 2.60	47.1	.....	C. (0.5)* 2.1	(2.54.) 2.90	.....	.....	.....	.....	21.0	.....
New York, N. Y.	1,515,301	365.2	87 9	3.35	0.9	.....	4.4	3.10	.....	.....	0.1	.....	6.6	0.45
Paterson, N. J.	78,347	40.5	S. 8.7 (e)	2.20	S. 3.7	1.00	.....	.....	.....	.....	.....	.....	87.5	.....
Philadelphia, Pa.	1,046,964	762.2	(b) 15.7 (e)	2.41	64.3 (j)	.....	(2.4)* 3.2	2.50	2.6.	2.05	.....	.....	11.6	.....
Pittsburg, Pa.	238,617	154.0	M.	1.60 to 3.10	.....	.....	M.	3.35	.....	.....	.....	.....	.....	.....
Rochester, N. Y.	133,896	.....	.....	2.00	.....	.....	.....	C. 2.75	.....	2.45	.....	.....	.....	.....
Syracuse, N. Y.	88,143	9.1	C. 39.5	3.69	C. 16.6	.....	C. 20.8	.....	C. 14.3	2.23	.....	.....	4.8	1.03
Toledo, O.	81,434	62.8	S. 32.9	1.90 to 3.50	S. 6.9	.....	C. 16.1	2.55	.....	1.55	S 26.1	1.05	.....	.....
Washington, D. C.	230,392	169.9	15 (a)	2.83	16.3	.....	(6.2)* 29.2	(2.12) 2.12	11	.....	.....	.....	6.3	.....
SOUTH ATLANTIC, SOUTH CENTRAL AND SOUTHWESTERN STATES.														
Atlanta, Ga.	65,533	42.6	S. 100	$1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kansas City, Kan.	.....	33.8	C. 0.6	2.74	.....	.....	C & M. 4 4	$2.55	S. 1.5	$1.95	C. 75.1	$1.50	17.7	$1.00
Kansas City, Mo.	132,716	69.7	S. 4.	2.90	.....	.....	C. 12.	2.80	C. 3.	2.60	C. & S. 74.	1.35	7.	0.60
Louisville, Ky.	161,129*	176.1	C. 11. (a)	2.85	M. 6.	$1.75	C. 5.	3.00	.....	C. 1.50	.....	.....	78.	1.25
New Orleans, La.	242,039	75.	C. S. 33. (k)	4.50 to 5.50	.....	.....	C. 26.6	3 70	.....	.....	.....	.....	.....	.....
Richmond, Va.	81,388	30.9	S. 81.5 (l)	2.45	.....	.....	.....	.....	.....	.....	.....	.....	18.4	0 90
St. Louis, Mo.	451,770	347.4	C.12.5 (a)	2.97	.....	.....	C. 1.1	.....	.....	.....	C. 1.7 (m)	1.62	84.8	.....
Topeka, Kan.	31,007	20.6	S. 17. (n)	1.40 to 2.25	.....	.....	C. 53.4	2.80	C. 19.4	1.61	S. 9.5	2.25	.....	.....
Wilmington, N. C.	20,056	32.	M. 10.1	1.84	64.	0 58	(1.4)*	(2.06)	0.1	2.24	.....	.....	18.8 (s)	(1.19 (0.58
NORTHWESTERN STATES.														
Des Moines, Ia.	50,093	26.	.....	.....	.....	.....	.....	.....	S. 38.	$1.58	62.	$1 30	.....	.....
Lincoln, Neb.	55,154	27.6	S. 2 1	$2.40	.....	.....	.....	.....	S. 53.2	1.75	C. 44.5	1.71	.....	.....
Minneapolis, Minn.	164,738	36 8	10.8	.....	.....	.....	3 5	.....	.....	.....	85.6	.....	.....	.....
Omaha, Neb.	140,452	90.8	C. 33. (o)	2.08 to 2.55	.....	.....	C. 25.	$2.08	.....	C. 1.84 (p)	C. 42.	1.52	.....	.....
St. Paul, Minn.	133,156	49.4	1.	2 44	.....	.....	C, 10.	2.64	2.	2.54	C. 86.	(1.32 (1.42	.....	.....
Sioux City, Ia.	37,806	28.7	.....	.....	.....	.....	.....	.....	P. 1.	1.69	99.	1.45	.....	.....
PACIFIC STATES.														
Denver, Colo.	106,713	C. 4.7	20.1 (q)	.....	.....	.....	C. 79 9	$2.35	.....	.....	.....	.....	.....	.....
Portland, Ore.	46,385	8 0	E. 66.9 (a)	2.55	24.8	.....	C. 3 7	3 00	.....	.....	5.6	.....	.....	.....
Salt Lake City, Utah	44,843	0.4	S. 72.	2.50	.....	.....	C. 28.	3.25	.....	.....	.....	.....	.....	.....
San Francisco, Cal.	298,997	95.	b. 25. (r)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tacoma, Wash.	36,006	15.4	.....	.....	.....	.....	.....	.....	.....	.....	0.7	$1.25	.....	.....

* Figures in parentheses are for block asphalt, all others are for sheet asphalt. (a) Granite block. (b) A small portion of this is granite block. (c) Belgian block. Some cobble. No figures except cost given. (d) Three-fourths granite, cost $2.63; one-fourth Belgian block, cost $1.80. (e) Belgian block. (f) Cobble, 79 cts.; rubble, 94 cts. (g) About three-fourths granite block and one-fourth limestone block. (h) About four-fifths granite block, cost $3.73, and one-fifth sandstone block, cost $3.47. (i) Medina sandstone. (j) About three-fourths cobble and one-fourth rubble. (k) About two-thirds stone block, cost $4.50, and one-third Belgian block, cost $5.50. (l) A small portion is granite rubble. (m) Largely pine block. (n) About five-sixths sandstone block, cost $2.25; remainder limestone block, cost $1.40. (o) Granite block, $2.55; sandstone block, $2.08. (p) Brick included under stone block. (q) Sandstone. (r) Basalt. (s) Telford, $1.19; macadam, $0.58.

some of the side streets and alleys would be well served by this pavement. The use of vitrified bricks for heavy traffic should not be attempted, and their use on business streets should not be urged too strongly or adopted hastily until thoroughly tested on less important streets.

It is unfortunate, but true, that after a pavement is laid, city authorities usually conclude their work done, when in reality it is only commenced. We know very little in this country regarding the proper maintenance of street pavements. We rarely ever provide for maintenance. If pavements were properly repaired and maintained, several years would be added to their life. Abroad, pavements are constructed at a fixed sum for first cost, and a fixed price contracted per square yard per annum for a period of fifteen to eighteen years, the contractors being compelled to repair and properly maintain the pavements for the price and period contracted.

If the charter permits, when contracts for pavements are awarded, the price per square yard should include proper repairs and maintenance for five years free of cost to the city, under exact and intelligent inspection, and the following ten years at the rate of two or three per cent. of its cost, payable annually.

TABLE 3.

Exceptional Kinds of Pavement (other than Stone, Macadam, Wood, Asphalt and Brick) in 12 American Cities.

City.	Character of pavement.	P. c. of total.	Cost per sq. yd.
Baltimore, Md.	Granolithic	.....	$2.80
Boston, Mass.	Gravel	34.4	....
Chicago, Ill.	(Slag) Burnt clay	....	0.75
Columbus, O.	Burnt clay	4.8	2.29
	Gravel	56.8	
Dayton, O.	C. Burnt clay.	32.	2.44
Grand Rapids, Mich.	Gravel	87.	....
New Orleans, La.	Gravel concrete	40	1.50
St. Louis, Mo.	Nicholson	0.05	....
San Francisco, Cal.	C. Bituminous rock	75	2.25
Syracuse, N. Y.	Sandstone and Asphalt	3.7	....
Tacoma, Wash.	Plank	8 8	0.70
	Bituminous rock	11	2.70
Wilmington, N. C.	Shells and clay	5.5	....

TABLE 4.

Average Life in Years of Granite Block, Wood, Asphalt and Brick Pavements in 21 American Cities.

	Granite block, years.	Wood, years.	Asphalt, years.	Brick, years.
Brooklyn, N. Y.	50	....	....	....
Buffalo, N. Y.	....	....	10	....
Chicago, Ill.	20	8	20	....
Cincinnati, O.	20	8	15	12
Columbus, O.	40	....	15	8
Des Moines, Ia.	....	6 to 8	....	15
Ft. Wayne, Ind.	....	8	....	....
Louisville, Ky.	30	....	5	....
Montreal, P. Q.	25 to 30	5 to 7	5 to 10	....
Newark, N. J.	40 to 50	....	15	....
New York, N. Y.	....	....	15	....
Omaha, Neb.	....	6	2 to 6	....
Philadelphia, Pa.	10 to 15	....	5 to 7	....
Providence, R. I.	40	....	....	....
St. Louis, Mo.	25	5	15	....
St. Paul, Minn.	....	6	....	....
Sioux City, Ia.	....	6 to 8	....	15 to 20
Syracuse, N. Y.	....	....	5 to 10	5 to 10
Toledo, O.	15 to 30	8 to 10	15 to 30	15
Washington, D. C.	....	....	10 to 20	....
Quebec, P. Q.	20	10	....	....

TABLE 5.

Cost of Maintaining Granite Block, Asphalt and Macadam Pavements in Cents per Square Yard per Year in Five American Cities.

	Granite block. Cents.	Asphalt. Cents.	Macadam. Cents.
Hartford, Conn.	....	....	2
Louisville, Ky.	1/2	1	2 1/4
Omaha, Neb.	1/4	8	....
Quebec, P. Q.	16 1/2	.....	1.1
St. Louis, Mo.	1/2	4 1/2	8 3/4

TABLE 6.

Average Life in Years of Granite, Porphyry, Asphalt, Wood and Macadam Pavements in Seven Foreign Cities.

	Granite, years.	Porphyry, years.	Asphalt, years.	Wood, years.	Macadam, years.
Berlin	....	....	35	22	7
Birmingham.	28	....	....	10	21
Dresden	40	30	....	....	15
Leipzig	....	....	....	....	....
London	....	....	15	5	....
Paris	30	30	15	8	....
Vienna	35	....	20	10	....

TABLE 7.

Cost of Maintaining Granite, Porphyry, Asphalt, Wood and Macadam Pavements in Cents per Square Yard per Year in Seven Foreign Cities.

	Granite, cents.	Porphyry, cents.	Asphalt, cents.	Wood, cents.	Macadam, cents.
Berlin	....	....	....	33	3.5
Birmingham.	6 to 14	....	....	15 to 18	8 to 12
Dresden	1.2	....	....	....	4.5
Leipzig	1	1.3	....	....	....
London	....	....	2	31	4 to 7.5
Paris	....	12	31	39	3.7
Vienna	....	....	4.7	....	32.6

THE OLDER WATER-WORKS OF CONSTANTINOPLE.

The ancient water-works of Constantinople present many curious and interesting features. We abstract the following from a description by Mr. Forchheimer in the "Zeitschrift des Vereines Deutscher Ingenieure:"

The structures for the water supply of old Constantinople date back partly to the Byzantine period and have preserved their peculiar character to this time, while the more recently constructed water-works of the city differ in the whole but little from similar plants in other countries.

To insure an abundant supply of water the wooded foot-hills of the Balkan mountains, about eleven miles north, were selected for the location of collecting ponds, from which the water could be conducted to the city by gravity. The dams, which are partly of Byzantine, partly of Turkish origin, have vertical walls, reinforced by buttresses, and vary between 29 and 43 ft. in thickness, with rubble cores and ashlar dressed masonry lining. They are richly ornamented and sometimes lined with marble. There are no overflows. The water is shut off in a primitive way by a number of conical valves, for the tending of which a keeper is appointed.

From these ponds the water is conveyed to the city in arched conduits of 24 to 28 ins. width in the clear, with stone-slab channels 12 to 16 ins. wide at bottom, in which the water flows from 8 to 12 ins. deep. Some aqueducts of considerable dimensions, carrying the water over the valleys, are still in existence, and are capable of supplying the city with about 3,170,000 gallons per day.

A two-story aqueduct of 14 ft. height, which is said to have been at least 4,000 ft. long, of which 2,000 ft. are still standing, spans a valley in the city itself. It is of Roman origin, and was finished about 368 A. D. Another aqueduct, built by Justinian, is 115 ft. high. Its lower story consists of pointed arches of 54 ft. span; the upper one has arches of 44 ft. width. The columns have sloping sides and are connected transversely by smaller arches. The structure has a roof-covering of stone slabs. The two-story aqueduct of Dschebedschi-Koe is 105 ft. high, 558 ft. long, and has pointed arches of 19 and 20 ft. span. The piers, covered with pointed slab-roofs, are 16.5 ft. thick. The "crooked aqueduct," following the direction of a valley for a distance of 708 ft., then turning at a right angle, is 112.5 ft. high above the bottom of the valley, and built in three stories, of which the lower is carried by pointed, and the two upper ones by semi-circular arches. Total length, 1,122 ft.

The largest existing aqueduct, called the "long aqueduct," is of Turkish origin, and consists of two stories with pointed arches. Its total length is 2,289 ft., its height 83 ft.

The aqueduct of Bagtsche-Koe has been constructed at a comparatively recent period; its length is 918 ft.

Where pipe conduits are in use, the material used for such is wood, clay, or, for extremely high pressure, lead. The clay pipe is in lengths of 12 ins., with one end contracted to permit of inserting it into the end of the adjoining length. The calking material employed consists of linseed oil, powdered lime and cotton. In order to avoid great pressure in clay-pipe lines so-called "suterasi" were erected every 600 ft. These are towers carrying a sheet-iron elevated tank, into the top of which the water is discharged. A descending pipe carries the water with diminished pressure from the tank to the main below. These structures are all of Turkish origin.

The water from the main empties into a "taksim" (divider). This is a trough which is fitted with a row of horizontal openings for the purpose of distributing the water to the different conduits. If a conduit is to be shut off the corresponding holes are closed simply with a bunch of weeds or wood shavings.

Within the limits of the city only three reservoirs are connected with the existing mains. In former times a considerable number of reservoirs for the storage of water were used.

THE AUSTRIAN TORPEDO STORESHIP "PELICAN."

The Austrian torpedo storeship "Pelican" is 279 ft. in length, 41 ft. beam, 17 ft. draft, 3,000 tons displacement, and is provided with a triple expansion engine of 5,000 I. HP. We abstract from "Dingler's Polytechnisches Journal" the following further description of the ship:

The "Pelican" is built to serve as storeship and protection for a fleet of torpedo boats; to this end she is furnished with stores, containing all the parts needed by torpedo boats, as reserve parts for engine, Whitehead torpedoes, ammunition, small arms and coal, which is ready stowed in bags. Separate loading cranes admit of transferring these things on the high seas. Spacious cabins for the marine reserves, which the vessel also carries, and well furnished hospital accommodations are provided. Two shops with the necessary implements permit of repairing defects on engines, etc., without delay. The "Pelican" is armed with a considerable number of rapid-fire and machine guns.

The stipulated speed as per contract was to be 16.5 knots. The trial trip was made in a heavy sea, and a distance of 36.9 knots was made with the wind in 1 h. 59 min., against the wind in 2 h. 3 min., giving the average speed of 18.3 knots. The engine, system "Schichan," worked very evenly, indicating 4,800 HP., with 140 revs. per minute. Steam is generated in two cylindrical double boilers, each of which has a length of 18 ft. 5 ins., 14 ft. 5 ins. diam. The material used for those is soft steel, of sufficient strength to withstand a working pressure of 160 lbs. On the trial trip only 1.66 lbs. of coal per I. HP. hour were consumed. The total weight of the engines and boiler plant, with water in boilers and condensers, including reserve parts, is 380 tons.

This vessel was built by F. Schichan, in Elbing, Germany. An armored corvette of 4,000 tons displacement, with 9,000 HP., and several torpedo boats for the German navy, are in course of construction at the shops mentioned. The torpedo boats are to be 147.5 ft. long, and are to have an average speed of 23 to 24 knots.

AN EXTENSIBLE BRACE FOR SEWER EXCAVATION.

We illustrate herewith an extensible metal brace for use in supporting the sides of sewer or other trenches in place of the ordinary timber struts. The brace is made of a heavy lap-welded iron pipe, into which enters a 1½-in. steel screw-threaded rod. A nut on this rod, bearing against the end of the pipe, permits the length of the brace to be adjusted as desired. The end-shoes of the strut have sharp edges, to secure a firm grip against the timbering; and the ball-bearing connection with the barrel of the strut insures a straight thrust upon it regardless of the inequalities in the bearings of the end shoes, or in their relative position. Fig. 1 is a section of one of these braces, which clearly shows the details of its construction. Fig. 2 shows the braces in use in a deep sewer trench. Contractors will doubtless appreciate the advantages of portability and security which these braces offer. In difficult ground we should judge them to be of special advantage, as they can be quickly made tight by screwing them up,

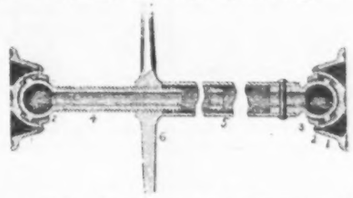
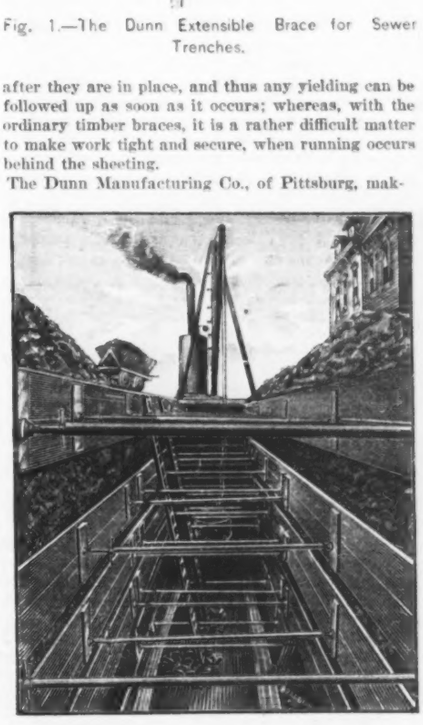


Fig. 1.—The Dunn Extensible Brace for Sewer Trenches.

after they are in place, and thus any yielding can be followed up as soon as it occurs; whereas, with the ordinary timber braces, it is a rather difficult matter to make work tight and secure, when running occurs behind the sheeting.

The Dunn Manufacturing Co., of Pittsburg, mak-



The Dunn Brace in Use in a Deep Trench.

ers of these braces, offer to send a dozen or more to responsible contractors for 30 days' trial, at the end of which time they may be returned if not satisfactory.

"STRAIN."

A correspondent of the Engineering News, by writing to that journal to propose a new definition of the word 'stress," as used in engineering science, gives the editor a chance to express his views on the use of the terms "stress" and "strain," which he does in one of the most vigorous, conclusive, and altogether admirable articles we have read for some time.

In this article the use of the word "strain" to express deformation or distortion of a body is severely condemned, and conclusively shown to be directly contrary to the analogies and derivation of this and similar words in many languages having their roots in the Aryan tongue.

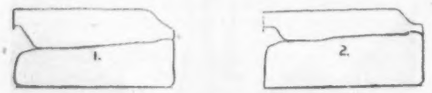
It is shown, we think, conclusively, why it is so difficult to get students and others encountering this use of the term for the first time to sense its meaning in that connection, the ordinary meaning of the term being not a distortion, but an applied force resisted by an equal force, the two producing a condition of equilibrium.

Our contemporary then shows how much more natural it is and how much clearer the matter becomes when "strain" is used to signify the applied force, "stress" the internal resistance to that force, and "distortion" to signify the deforming effect of the equal and opposite "stress" and "strain," and says: "If our scientific men, who are so over ready to coin new words and meanings of words nowadays, would first make sure that they understand and have exhausted the resources of the living tongue, they would coin fewer words, and yet greatly add to the clearness of their writings or teachings. It is hard enough for the human mind to grasp new thoughts. Do not make it harder by needlessly demanding that new words shall be learned to express those thoughts, especially when those words do violence to the very genius of the language, and of all languages."

In all of this we heartily concur, and it seems to us that it is not yet too late to return to the proper use of the terms in question. Usage will govern these matters, and if there could be anything like a general agreement to use the terms in their original and proper sense, dictionary makers and textbook makers would have to be governed by that usage.—"American Machinist."

COMPARISON OF INDICATOR DIAGRAMS OF SIMPLE AND COMPOUND LOCOMOTIVES.

From the report of the Master Mechanics' Association Committee on Compound Locomotives we have selected the accompanying indicator diagrams, which are stated to be typical ones and which show the performance of the two locomotives (which were essentially duplicates of each other in details other than the cylinders) when running at the same speeds. Among the interesting points noticeable in studying the diagrams is the throttling of the steam in the supply ports of the simple engine when running at 33.7 miles per hour with a cut-off of 7 ins. (27% of the stroke). The card taken at 16 miles per hour with a 10.7 in. cut-off shows hardly a trace of throttling. Comparing the simple and the compound it is noticeable that the compound shows little throttling at 33.7 miles per hour; one reason for this is that it cuts off so much later in the stroke than the simple engine. At the highest speed, 43 miles per hour, the power of the two cylinders of the compound was practically identical. At a speed of 11 miles per hour the low pressure cylinder did twice as much work as the high pressure. With the starting valve open the proportion of work done by the low pressure cylinder is even greater, as shown by the following two cards:

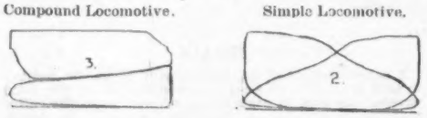


Compound at 3 Miles per Hour; Starting Valve Open

Boiler pressure	180 lbs.	179 lbs.
Cut off, ins.	h. p., 21.6; l. p., 24.6	Same
Mean eff. press.	h. p., 74.93; l. p., 95.52	h. p., 56 : l. p., 111.4
I. HP	h. p., 17.43; l. p., 63.24	h. p., 13.03; l. p., 73.76
Total I. HP	161.34	173.58

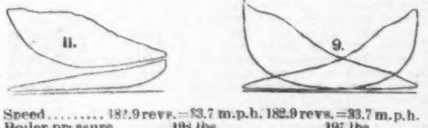
It will be seen that with the starting valve wide open the low-pressure cylinder did nearly five times as much work as the high-pressure cylinder. With the starting valve partially open, as shown in the left hand diagram, the work done in the two cylinders was as 1 to 4. The power generated by the compound locomotive with the starting valve open is very large considering the low speed. The indicated horse power shown by the left hand card above was 173.58 HP., or 5,728,140 ft. lbs. per minute. Deducting 5% for the internal friction of the engine and 10 lbs. per ton for the resistance of the locomotive itself, we have 5,280,693 ft. lbs. per minute as the work done by the locomotive on the train; and as the train was moving at a speed of 264 ft. per minute, this corresponds to a drawbar pull of $5,280,693 \div 264 = 20,000$ lbs.

Compound Locomotive. Simple Locomotive.



Speed	61 revs. = 11.3 m.p.h.	61 revs. = 11.3 m.p.h.
Boiler pressure	179 lbs.	176 lbs.
Cut off, ins	h. p., 21.6; l. p., 22.6	mean 12.5
Mean eff. press.	h. p., 91.6; l. p., 95.6	106.6
I. HP	h. p., 82.58; l. p. 163.36	
Total I. HP	495.86	428.7

Speed	92.1 revs. = 17 m.p.h.	86.8 revs = 16 m.p.h.
Boiler pressure	198 lbs.	196 lbs.
Cut-off, ins.	h. p., 21.1; l. p., 22.3	mean 10 7
Mean eff. press.	h. p., 122.4; l. p., 54.4	124.9
I. HP	h. p., 101.4; l. p., 304.1	
Total I. HP	731.	716.5



Speed	182.9 revs. = 33.7 m.p.h.	182.9 revs. = 33.7 m.p.h.
Boiler pressure	198 lbs.	197 lbs.
Cut-off, ins.	h. p., 14.3; l. p., 16 8	mean 7
Mean eff. press.	h. p., 78.2; l. p., 219	88.95
I. HP	h. p., 196.8; l. p., 322.4	
Total I. HP	838.4	807.7

Compound Locomotive. Simple Locomotive.

Speed	203.3 revs. = 375 m. p. h.	203.3 revs. = 37.5 m.p.h.
Boiler pressure.	174 lbs.	200 lbs.
Cut-off, ins.	h. p., 13.3; l. p., 15 8	mean 5 1
Mean eff. press.	h. p., 53.9; l. p., 20.5;	45.89
I. HP	h. p., 156.6; l. p., 109.9	
Total I. HP	653	614.1

Speed	233.1 revs. = 43 m.p.h.	223.5 revs. = 41.2 m.p.h.
Boiler pressure.	175 lbs.	173 lbs.
Cut-off, ins.	h. p., 13.3; l. p., 15.8	7
Mean eff. press.	h. p., 50.4; l. p., 17 9	51.72
I. HP	h. p., 168.1; l. p., 166 5	
Total I HP	675.2	763.7

Indicator Diagrams from Vauclain Compound Locomotive and from Simple Locomotive Running at the Same Speeds.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

UNIVERSITY OF MICHIGAN; ADDITIONAL NOTE.

The first act for the formation of the University of Michigan was passed as early as 1817, when the entire population of the territory did not exceed 7,000, of whom a large majority were French Canadians at Detroit, Monroe, and other points in the southeastern part of the state. This section of the state began to be settled by the French as early as 1668. Even in 1817 no territorial legislature had been created, but the federal governor and judges acted as legislators. This body framed and passed the following curious law, which has both an amusing and an impressive and pathetic side. When we consider that these legislators represented a community which was as yet a mere handful of unlettered backwoodsmen, who as yet had neither capital nor the most ordinary comforts of civilization, and who were nearly a thousand miles away from any considerable university, it cannot be denied that they showed a remarkable enlightened public spirit, if somewhat uncouthly. We quote only a part of the act. It is entitled: "An Act to Establish the Catholepistemiad or University Michigania."

"Be it enacted by the Governor and Judges of the Territory of Michigan, that there shall be in the said territory a catholepistemiad or university denominated the Catholepistemiad or University Michigania.

"The Catholepistemiad or University of Michigania shall be composed of thirteen didaxum or professorships; first, a didaxia or professorship of catholepistemia, or universal science, the dictator or professor of which shall be president of the institution; second, a didaxia or professorship of anthropoglassica, or literature, embracing all of the epistemum or sciences relative to language; third, a didaxia or professorship of mathematica or mathematics; fourth, a didaxia or professorship of physiognostica or natural history, etc." The act thus continues through the whole range of the "thirteen didaxum." The remaining nine are as follows: Natural philosophy, astronomy, chemistry, medical sciences, economical sciences, ethical sciences, military sciences, historical sciences, and intellectual science.

It is impossible to read these "words of learned length and thunderous sound" without a smile, but the smile dies upon one's lips when one remembers that these words, after all, laid the foundation of the University of Michigan, one of the noblest, most successful and most original institutions ever created out of nothing by the fiat of a state. Moreover, there was nothing absurd about the act except its "foot and a half" words. On the contrary, all the more novel and more essential features of the modern university were in the act, and it was full of practical wisdom and plain "horse-sense." Under the act, the university was to be the apex of the pyramid of state public schools. It was to be governed by the faculty who were to be appointed by the Governor. It was to be supported by an increase of 15% (!) in the state taxes, an amazingly liberal provision. After the fashion of the times, it was to have power to raise still more money by means of lotteries. The "First College of Michigania" was established at Detroit in October, 1817, and to show the spirit of the people, a subscription from Montreal and Mackinaw for the sufferers from the Detroit fire of 1805, which for some reason could not be distributed at the time, was by request of the sufferers themselves turned over to the university.

This first act is supposed to have been drawn by Hon. A. B. Woodward, then presiding judge of the Supreme Court of the Territory of Michigan, and few men have deserved more honor from their state and country for any single act. By a law passed four years later (April 30, 1821) the objectionable features of the former act were weeded out, including the absurd phraseology, the excessive taxing power and the lottery provisions, but all its essential features were retained, and "The University of Michigan" thus created in substance as it stands to-day. It had still to pass through a long formation period, however, before it was to attain real importance, and it was not till 1837 that the institution was closely assimilated to its present form. "Not till 1867, when the university had already become strong and renowned, when pupils were more numerous than those of any other institution in the land, was the state called to give the first penny for its support, and then the whole appropriation was $15,000 per year, which was a tax of just 1-20 mill on the appraisal of the taxable property of this rich commonwealth." The appropriations are now much more liberal, and in all the state has given over $2,000,000 to the university, while from its early land grants, which were fairly well managed, the university has derived some $1,200,000.

TIRE BREAKAGES IN GERMANY.

From the statistics of tire breakages for the seven years, 1884 to 1890, published by Railway Director Bork, we abstract the following:

The average of tire breakages for the seven years mentioned was 0.28 per 100. For the different classes of rolling stock the breakages compare as follows:

		Wheels.
Locomotives	0.5 per	100
Tenders	0.65 "	100
Passenger coaches	0.38 "	100
Mail cars	0.6 "	100
Baggage cars	0.39 "	100
Freight "	0.25 "	100

In the year 1890 thirty derailments were traced directly to tire breakages. The breakages most prevalent are transverse fractures.

The influence of the temperature upon the number of fractures is shown in the following table, giving the ratio between tire breakages in summer and winter:

	Summer.	Winter.
In 1884	1	1
1885	1	1.5
1886	1	2.4
1887	1	2.6
1888	1	3.1
1889	1	3.3
1890	1	4.4

The average ratio is 1:2.6. The greater number of breakages in winter do not occur in severe weather, but when it is beginning to thaw, and while the ties are yet rigidly frozen to the ballasting.

The following table shows the comparative number of breakages per 100 wheels in tires of different thicknesses:

Thickness.	No. of breakages.
Tires above 2⅜ ins.	0.025
" between 1⅞ " and 2⅜ ins.	0.08
" " 1⅝ " " 1⅞ "	0.29
" " 1½ " " 1⅝ "	0.54
" " 1⅜ " " 1½ "	1.05
" " 1⅛ " " 1⅜ "	1.65
" " ⅞ " " 1⅛ "	1.85

The influence of the brake-shoe pressure upon fractures has been greatly overestimated. The statistics show an average of 0.29 breakages per 100 wheels with brakes set, against 0.26 breakages with brakes off.

The statistics show that the material employed in the manufacture of tires also influenced the breakages to a great extent. The number of breakages per 100 wheels for the three materials used were for:

Puddle steel	0.67
Welded iron	0.43
Soft steel	0.27

The number of longitudinal fractures was 15.6% of the total tire breakages.

HEAVY FREIGHT LOCOMOTIVE; IRON RANGE & HURON BAY RAILWAY.

(With inset.)

In our issue of June 16 we illustrated a very heavy and powerful locomotive of the twelve-wheel or mastodon type, built by the Brooks Locomotive Works, Dunkirk, N. Y., for the Iron Range & Huron Bay Ry., and on our inset sheet this week we give the detail drawings of this engine. In the previous article above referred to we called attention to the remarkable growth in the size, weight and power of freight locomotives during the past few years. The first engine of this particular type, having eight coupled driving wheels and a four-wheel leading truck, was built by the Central Pacific Ry., and its dimensions, together with those of a twelve-wheel engine of the same date for the Lehigh Valley R. R., are given in the accompanying table. It will be noted in comparing the Central Pacific and Iron Range & Huron Bay engines that in the latter the total weight has increased 39,000 lbs., and the weight on the driving wheels 29,950 lbs., giving a weight per driving wheel of 17,000 lbs. instead of 13,456 lbs., or an increase of 3,544 lbs. per driving wheel. This is more clearly shown by the following table:

	Total W't. lbs.	W't on drivers. lbs.	W't per drivers. lbs.
I. R. & H. B., 1892.....	162,000	136,000	17,000
Cen. Pac.....	123,000	106,050	13,456
Increase, 1892.....	39,000	29,950	3,544

The original engine has hauled 20 loaded cars, weighing 844,000 lbs., up a long grade of 116 ft. per mile, while engines of the same type recently built by the Brooks Locomotive Works for the Great Northern Ry., and practically identical with the Iron Range & Huron Bay engine, will haul 1,156,000 lbs. behind the tender, on a good track comparatively free from curves. We had intended entering more fully into comparisons of early and recent freight engines of modern types, but have not yet been able to compile and prepare the necessary information, owing to the demands on our space and time due to the various conventions. We hope, however, to return to this subject in a later issue, and in the meantime the accompanying table of comparative dimensions will speak for itself.

	Cen. Pac.	Leh. Val.	I. R. & H. B.
Cylinders.....	19 × 30 ins.	20 × 26 ins.	20 × 26 ins.
Diam. of driving wheels.....	4 ft. 6 ins.	4 ft. 0 ins.	4 ft. 8 ins.
Diam. of truck wheels.....	..	....	2 ft. 4 ins.
Diam. of boiler barrel.....	4 ft. 6 ins.	4 ft. 3 ins.	5 ft. 8 ins.
Working boiler pressure.....	135 lbs.	125 lbs.	180 lbs.
Firebox, form.....	....	....	Belpaire.
" length.....	13 ft. 4½ ins.	11 ft. 6 ins.	9 ft. 6 ins.
" width.....	2 10	2 10	2 9
Tubes, number.....	186	190	291
" diam.....	2¼ ins.	2 ins.	2 ins.
" length.....	12 ft. 0 ins.	10 ft. 11¼ ins.	13 ft. 10 ins.
Heat. surf., tubes.	1,076 sq. ft.	935 sq. ft.	2,096 sq. ft.
" " firebox	182 "	179 "	224.5 "
" " total..	1,258 "	1,174 "	2,319.5 "
Grate area.....	25.74 "	32 "	....
Wheel base, driving	15 ft. 9 ins.	13 ft. 0⅛ ins.	15 ft. 6 ins.
" truck.....	....	....	5 10
" tot'l of engi'e	24 11¼	23 2	25 0
" of tender....	15 0¾	....	....
" engine and tender.. ..	53 1¾	46 9	52 0
Weight on drivers.	106,050 lbs.	82,432 lbs.	136,000 lbs.
" " truck....	16,950 "	19,264 "	26,000 "
" " total of engine.	123,000 "	101,696 "	162,000 "
" of tender...	63,000 "	53,818 "	78,000 "
" engine and tender...	186,000 "	155,514 "	240,000 "
Capacity of tank..	3,000 galls.	2,575 gall's.	4,000 galls.
" coal space	12,000 lbs.	8,9.0 lbs.	17,000 lbs.

ANNUAL ADDRESS OF PRESIDENT MENDES COHEN, AM. SOC. C. E.

A provision of the Constitution of the Society requires that the President shall deliver an address at the annual convention, and in compliance therewith, I have the honor to appear before you this evening. As I have not been of late years actively engaged in the practice of our profession, and am for that reason unable to give, from personal experience, notes of recent works and improvements, marking the strides of current progress in the science of engineering, it has been suggested to me that you would be interested in an historical narration of some of the events and problems of a much earlier period and the manner of meeting them in the construction, development and operation of the Baltimore & Ohio R. R. It must not be understood from my assuming to act upon this suggestion that I was one of those upon whom these early duties and responsibilities devolved. I was not born until some years after July 4, 1828, when the venerable Charles Carroll, of Carrollton, then the only survivor of those who signed in 1776, the charter of our liberties, turned the first sod and laid the first stone of the Baltimore & Ohio R. R. But many of the original actors and participants in these events were still upon the stage when, as a youth, I entered the locomotive shops of the late Ross Winans, with a view to preparation for the profession of a civil engineer.

Mr. Winans, a native, of New Jersey, was himself a most prolific inventor, and had produced previous to 1829, an improved journal and box, which he thought suited to railroad use, and which he took to England to test on the Liverpool & Manchester R. R., then under construction. He was there present when the celebrated trial of locomotives took place in 1829, and the opportunity thus afforded him for study of the locomotive was not lost, and was subsequently of much value, both to himself and the railway company. His journal and box were adopted on the Baltimore & Ohio R. R., and he, taking up his permanent residence in Baltimore, had been continuously, thereafter, engaged in designing and constructing cars and locomotives adapted to use on the railroad. In and about the establishment of Mr. Winans and the railroad works adjoining, were many of the men who had been employed at the very commencement of the undertaking, the actual participants in which have now nearly all passed away. Those men I used to meet constantly, and entering myself into the service of the railroad company a few years later whilst many of the original features of the work were still in existence, I had opportunities of acquiring facts and of observing details not so readily gathered or noted to-day. Being in this sense only a survivor of that early period, I venture to bespeak your interest and attention to some of the more prominent details of the work in which there was much originality. Many of these facts are known to some of you, many of them are here gathered from the original reports and other records of the time, some from a history of the Baltimore & Ohio R. R. prepared in 1883 by the late Wm. Prescott Smith, and others from the personal reminiscences of survivors, but I am not aware that they have ever before been brought together.

In 1825, Baltimore was a city of 70,000 inhabitants. Its people were enterprising and had developed with the country beyond the Alleghanies a large trade, transported in wagons, over good turnpike roads, whilst the foreign commerce of the port, conducted in its home-built, fast sailing vessels, known everywhere as "Baltimore clippers," extended to all parts of the world. Its geographical position giving it a saving of from 100 to 200 miles in distance to the Ohio River, at Wheeling, over that from Philadelphia or New York, to the same river at Pittsburg, was sufficient, when land transportation was effected only by horse and wagon, to give it an enormous advantage. Philadelphia and New York were making strenuous efforts to retain their trade, and to this end were pressing forward their respective lines of canal, the future possibilities of which, aided by steam navigation then rapidly developing, no imagination would limit. Baltimore had not failed to realize clearly that action was necessary. It was believed that the valleys of the Potomac and Youghiogheny rivers would afford a route for a canal quite as advantageous as any to the north of it. Washington himself had taken much interest in such a project and had presided in December, 1784, at a meeting in Alexandria, at which the Potomac Company was formed for improving the navigation of that river. In 1824 a charter for the Chesapeake & Ohio Canal was granted by Virginia and Maryland. Into this corporation was merged the Potomac Company, which had thus far only accomplished the opening of a partial slack water navigation. Preliminary surveys for the canal had been made and some definite location effected, when the hopes of Baltimore as to its commercial success were completely upset by the report of General Bernard, of the Board of Engineers on Internal Improvements, who, in 1826, showed not only the very great cost of the work, but that the scarcity of water on the Alleghanies, at the high elevation, over which the canal must pass, made its successful accomplishment very problematical; besides, its proposed eastern terminus was Georgetown, on the Potomac, and to reach Baltimore from that point would involve an additional cross-cut canal, some 50 miles in length.

The opening of the Erie Canal in 1825 aroused the merchants of Baltimore to a full sense of impending decadence, and discussions of the subject were constant between the more thoughtful of their number. If the projected canal was out of the question, what were they to do? Competition by the best of turnpike roads was hopeless.

At this time attention was being directed in England to the possibilities of railroads for general transportation purposes. Numerous short lines were already in existence there and very few had been laid even in this country, but so far as they were designed chiefly, if not altogether, for the purpose of moving mineral products from mines or quarries to a convenient point where water transportation would be available and were, in fact, what we would term to-day, mere tramways, and only operated reliably by horses. Might this new system be made available on a larger and much more extended scale for connecting Baltimore with the western waters. So thought Philip E. Thomas and George Brown, two of these Baltimore merchants. Having facilities for obtaining information from England in regard to what had been done there, these gentlemen took plans to procure all that was available from that source, and with it in hand, they invited a few of Baltimore's most influential citizens to meet them for the purpose, as their call stated: "To take into consideration the best means of restoring to the city of Baltimore that portion of the western trade which has lately been diverted from it by the introduction of steam navigation and by other course." This meeting was held at the residence of Mr. Brown on Feb. 12, 1827. It was well attended. After hearing read and discussing the various documents and statements illustrating the efficiency of railroads for the conveying of articles of heavy carriage at a small expense and the superior advantage of this mode of transportation over turnpike roads or canals, a committee was appointed to consider the subject, and was directed to report to an adjourned meeting one week later.

At this adjourned meeting it was determined to apply to the Legislature, then in session, for a charter for the Baltimore & Ohio R. R., which was obtained in the following month in such a comprehensive form that it remains to this day a monument to the forethought of those who prepared it. This was the commencement of the Baltimore & Ohio R. R., the first railroad enterprise undertaken for general commercial purposes—certainly in the United States, and far exceeding in magnitude anything then being promoted in England. Organizing at once under this charter, Philip E. Thomas became the first President of the company, and with an efficient Board of Directors, lost no time in prosecuting the work. Application was made to the United States Government for a detail of officers to conduct reconnoissances and surveys, to be at once undertaken, whilst the company would take time for a careful selection of a suitable chief engineer. In response to this application there were detailed to the railroad service: S. H. Long, Brevet. Lieut.-Col., U. S. Topographical Engineer; William Gibbs McNeill, Capt., U. S. Topographical Engineers; Dr. William Howard, U. S. Assist. Engineer; assisted by Mr. F. Harris, Jr., U. S. Assist. Engineer; Lieut. Joshua Barnay, U. S. Artillery; Lieut. Isaac Trumble, U. S. Artillery, Lieut. John L. Dellahaunty, U. S. A.; Lieut. Walter Gynn, U. S. A.; Lieut. William Cook, U. S. A.; Lieut. Richard E. Hazzard, U. S. A.; Lieut. Geo. W. Whistler, U. S. A.; Lieut. Fessenden, U. S. A.; Lieut. Thompson, U. S. A., and Mr. Guion.

The duty assigned to these officers was performed with so much assiduity that they were enabled to present on the 5th of April, 1828, a report which covered a general examination of the whole intervening region between the Patapsco and Ohio rivers and with so intelligent a discussion of many of the alternative lines that it is a matter of no little wonder how so much could be accomplished in so short a time through so rough a wilderness as the Alleghanies must have been in that day. The study of the route seems to have been based on the theory that the gradient of the road, to be worked probably by horses, possibly by locomotives, must be moderate, not exceeding 30 ft. per mile, as nearly uniform as possible, never undulating; that a very liberal amount of lateral curvature was admissible in furtherance of this, and for the avoidance of heavy cuts and fills; and that where summits were to be crossed and great differences of level of level to be overcome recourse should be had to inclined planes to be operated preferably by steam or water power.

The company had, in the meantime, secured the services of Jonathan Knight, Esq., of Pennsylvania, a civil engineer of experience, who had been engaged upon the National Road, between Cumberland and Wheeling, and who had served more recently under appointment of the U. S. Government as a Commissioner to extend that road from Wheeling through the States of Ohio and Indiana. A few days after the filing of the report of reconnoissances and survey, the Engineering Department was organized by placing it in charge of a Board of Engineers, consisting of the President of the Company, Mr. Philip E. Thomas; Col. S. H. Long, U. S. Topographical Engineers, and Jonathan Knight. The President had no knowledge of engineering, so there were two professional men with a layman to vote with one or the other and make a majority whenever a difference of opinion supervened. Captain McNeill was subsequently, Oct. 6, 1828, appointed a fourth member of the Board. On May 5, 1828, the Board of Engineers made a formal report recommending to the company the adoption of a route by the valley of the Potomac as affording by far the best passage through the South

Mountain, involving too the crossing by inclined planes of but one summit, that of Parr's Ridge, before reaching the Potomac. A few days later parties were started in the field to make definite location of the line. It is curious to note that in the midst of their labors in the location of a great line through a difficult country the Board of Engineers found they had quite as difficult a problem to solve in meeting the views of the citizens of Baltimore as to the city terminus of the line. Every merchant wanted it at his own door, and it was many years before the question was put to rest.

On July 4, 1828, formal commencement of the work was made by the laying of the first stone by Charles Carroll, of Carrollton, attended by a great procession and trades display, badges, music, etc.; and on the 14th of the same month the first letting of the work took place. That there was no time being then lost is clear, for at the annual meeting, less than 90 days later, the President reports that the grading for 1½ miles was completed.

Simultaneously with the location of the line at Baltimore a party had been sent to locate the road through the Narrows of the Potomac, at and beyond the Point of Rocks, where it was feared there might be contest with the Chesapeake & Ohio Canal Co. This was promptly effected and was followed by the acquisition of the coveted ground in fee simple,though to no purpose, as it presently appeared, for in the same annual report of Oct. 1, 1828, the President announced that the canal company laid claim to a pre-emption right to a location along the Potomac River through succession of right of the old Potomac Company. Injunction immediately stopped the work of the railroad and the company along the Potomac, and the litigation thus commenced was prolonged for several years, ending finally in the triumph of the canal company.

The same report announced the intention of the President and Board of Directors to send to England a deputation of engineers to make observations there and especially to study the application of moving power upon the roads then existing.

Mr. Knight, Capt. McNeill, and Lieut. Whistler were accordingly sent abroad in November, 1828. They made a very thorough examination of all the railroads then existing in England and returned to Baltimore in May, 1829. The report of the observations, though promised, was deferred and, if prepared, seems never to have been formally presented and never printed. At their very first meeting, April 12, 1828, the Board of Engineers appointed Mr. Casper W. Weaver, Superintendent of Construction, "whose duty it should be to aid in arranging contracts for the execution of work upon the railroad and to see that all contracts for the construction of said road be faithfully carried into effect and also to perform such other duties connected with the service as the Board of Engineers may direct."

Mr. Weaver had been engaged in a somewhat similar capacity on the construction of the National Road from Cumberland to Wheeling and its continuation in Ohio, and, although probably not equipped with a scientific education, had acquired considerable experience and practical skill in dealing with contractors and pushing public works. The Board of Engineers, on the contrary, with a most cumbrous organization, was dealing with entirely new problems where precedent and past experience were of little avail. The Superintendent seems to have thought he possessed far more knowledge of the subject than his engineers and would brook no control. He seems to have recognized their general lines of location, but modified and changed them occasionally as he thought fit. The Board of Engineers adopted in its printed regulations a thorough system in accordance with the military training and habits of a majority of its members and not differing from the methods observed in the government work. Mr. Knight united with his colleagues in the adoption of these regulations, all of which were doubtless right in themselves, but they were not elastic enough for the views of Superintendent Weaver, who did pretty much as he pleased without the slightest attention to regulations when he chose to ignore them. It is very evident to one who studies the record to-day that the Superintendent had the ear of the President and was sustained by him and the Board of Directors. They wanted the work driven with energy in order to impress the public with confidence in the success of a new and untried enterprise, for the company was seeking support and subscriptions to its stock from both the State and United States Governments. Mr. Weaver seems to have rushed things, which was what they wanted, and the man who, without drawings or prepared plans, would assume to put contractors to work on dressed stone viaducts of 80, 55 and 20 ft. spans, at an estimated cost but little exceeding that which the Board of Engineers had named as the cost of wooden superstructures, adopted by them for economy, was the man for the day. Col. Long seems to have had much trouble from this cause during the absence of his colleagues in England. On their return in May, 1829, there was an investigation. Charges were preferred against the Superintendent, such as changing location without authority, injudicious dealings with contractors, entire disregard of certain specific orders of the Board of Engineers, etc. A hearing was had before a committee of the Board of Directors which acquitted the Superintendent of all charges affecting his integrity and practically sustained him throughout. The Board of Directors soon thereafter, Jan. 4, 1830, abolished the Board of Engineers and appointed Jonathan Knight as Chief Engineer. This action gave rise to much acrimonious discussion in the newspapers of the day. A pamphlet of some 500 pp. was published giving minute details of the work of the Board of Engineers from the first organization of the Board to its final dissolution, and this, in connection with other pamphlets and newspaper articles, gives a pretty clear insight as to the actual condition of affairs. A study of it is interesting as showing how the engineers were led, principally by local jealousies as to the point of entrance into the city, combined with a supposed necessity for avoiding undulations in the grade which had been located as a level for the first six or seven miles, to the adoption of a most expensive line within the first three miles from the city, involving a costly viaduct and one through-cut of 310,000 cu. yds. It was thought by this location, "a line of road would be secured which, by some extensive embankments and sharp cutting near the city, could be located with but a single summit for a distance of 180 miles and with but two summits requiring stationary power along the entire distance to the Ohio River."

It enables us further to appreciate how thoroughly novel and untried were the problems involved. We find an elaborate defense of the proposition that the flanges of the wheels should be on the outside of the wheel and rail, an arrangement which the Board of Engineers had adopted and in accordance with which 1½ miles of track had been actually laid, when shortly after the abolition of the Board of Engineers, the Chief Engineer changed it to that which was then used abroad, and which has since everywhere prevailed.

Mr. Knight, in his annual report of October, 1830, explains the reason for the change of plans and discusses the question very fully; the result being that, whilst his analysis would seem to justify the conclusion that the flange was better on the outside and in that position peculiarly well suited to Mr. Winans' patent car, which it was proposed to use, yet as experiments on the Liverpool & Manchester R. R. had shown that this car would work well with the flanges inside, it was desirable that a railroad which must be a general thoroughfare and probably intersected by numerous branches should be suited to all approved kinds of carriages, of which all, so far, had inside flanges; hence the conclusion to adopt upon this road the form already in use elsewhere. The same report contains an elaborate discussion and analysis of the size, weight and form of the chilled cast iron wheel to be used on the road with the proper amount of cone to be given to the tread, resulting in a pattern which was standard for the next 20 years or more. Of cars, a number were constructed at this time with case-hardened or steel journals and chilled bearings, a system which also continued in use for over 20 years.

Here, I must mention the name of John Elgar, Mr. Knight's mechanical assistant, who was employed in designing and constructing wheels, chairs and turnouts or switches. The latter were still used in and about the yards and street tracks of New York some 25 years later, where they were known as Baltimore switches. When I knew Mr. Elgar 45 years ago, he was an old man of about 70 years, gentle and minutely painstaking in all he did. He was then interested in water rams which were constructed for him in Winans' shops. I was frequently assigned to his work and learned to know him well. In fact, the first time I ever held a target was for him in running a line of levels for setting one of his rams to supply water to the Baltimore House of Refuge. The level he used was peculiar. He was too poor to buy an ordinary telescope level and much too independent to borrow one, so he made his own. Its use did involve the necessity of being reasonably careful about equal sights, but it served his purpose well and the four silver quarters which he insisted on my accepting for my afternoon's duty as rodman was the first pay I ever received for engineering work.

The dissolution of the Board of Engineers was soon followed by the retirement from the company's service of all the United States officers heretofore attached to it. They were all men of ability, and each and all subsequently made a record elsewhere; but it is very evident that the President and Board of Directors had effected a most impracticable organization at the outstart under which it was well nigh impossible to produce good results.

The track was to have been laid throughout on stone sills, but owing to the scarcity of stone until the valley of the Patapsco could be reached, and for the further reason that the embankments constructed without regard to the direction of the engineers, who had ordered them built in compacted layers of full width as you would build an earthen dam, were not sufficiently settled to afford a proper bed for the stone, it was deemed best to lay the first seven and a half miles with wood. Sleepers or cross ties from 7 to 8 ft. in length and 5 to 10 ins. in thickness were laid transversely on the road at a distance of 4 ft. from center to center. Notches were formed in each sleeper at proper distances to receive stringer pieces 6 ins. square and from 12 to 40 ft. in length. These were held in place by wooden keys. Under each notch of each sleeper a cavity was excavated in the graded bed to receive 1½ cu. ft. of broken stone of a size to pass through a 2-in. ring. This cavity was arranged 18 ins. lengthwise on the sleepers and 12 ins. lengthwise of the road and 12 ins. deep. Each sleeper was laid so as to rest firmly on these supports of broken stone. The iron rails 15 ft. long by 2¼ ins. wide and ⅝ in. thick were laid on the stringers about ¾ in. from the edge. Iron plates having been let into the wood immediately under the joinings of the iron rails, the ends of each two adjoining rails were fastened to the plate by a screw bolt or nut, or by a nail or spike. The rails were laid ¼ in. apart with mitered joints and were nailed to the wood throughout, through holes made in the rail for the purpose. The projecting corner of the stringer was then adzed off so that the flange of the wheel might come into contact with the wood. On the unsettled embankment subsills were used under the sleepers or cross ties. For the first seven miles a double track was constructed of this description and on the next six miles, which carried the work to Ellicott's Mill, one track was made with the wooden stringers on stone blocks about 16 ins. square by 12 ins. long, bedded in broken stone, instead of on wooden sleepers or cross ties. The rails were secured to the block by cast iron knees. The other track consisted of stone sills about 16 ins. wide by 12 ins. deep bedded in broken stone, forming a continuous base for the iron strap rail. The latter was the standard track, and it is recorded in the reports as believed to be the best known, and superior to the iron rail in use in Europe. Its cost was $2,000 per mile for each track more than the wooden stringer, but its supposed permanency recommened it to the company wherever the proper material could be had.

It was not long, however, before experience began to enlighten the officers to a fact which the President announced a little later, that of the several systems of superstructure just described the first, intended to be but temporary, was decidedly the best, and the last was decidedly the worst of all. The track was finished with a horse path of gravel on broken stone and was opened for use to Ellicott's Mills May 21, 1830, being operated by horses.

Among the Assistant Engineers in charge of the track-laying are found the names of J. Dutton Steele and Squire Whipple.

So much extra expense had been involved in the laying of the new track with the stone sills, owing to the distance from the quarry and the difficulty of distributing them ahead of the track, together with the evident inexpediency of using them on unsettled embankments, that as the work preceded west of Ellicott's Mills the Chief Engineer suggested whether the extension could not be more advantageously laid with wood; leaving the stone, or other approved methods, to be availed of for renewals. This policy was not adopted, however, until about 40 miles of single track had been laid with the stone. In his annual report of Oct. 1, 1830, Mr.Knight speaks with much satisfaction of the readiness with which a speed of ten miles per hour has been maintained with horses in the working of the 13 miles of road then in use for four or five months. He refers also to the recent eminently successful demonstration of the applicability of the locomotive to a railway with curvatures of 400 ft. radius as proved by the trial upon the road of an experimental engine built by Peter Cooper, of New York. The engine was rudely constructed, had but a single working cylinder of 3½ ins. diameter, and was mounted on the ordinary 30-in. car wheels which were driven from the engine shaft through the medium of gearing. This, the first trip of the first locomotive built in America, took place Aug. 28, 1830. A most graphic description of the trial trip was prepared many years ago by the late John H. B. Latrobe. No doubt many of you may recall it and I will not detain you with reference to it further than to say that the machine was a mere experiment to prove to the skeptic that the sharp curves of 400 ft. radius, or even less, could be readily worked by steam applied through the adhesion of the wheel to the rail. Peter Cooper was interested in proving this, for he was the largest owner of shares in the Canton Co., Baltimore, a real estate corporation that all who know anything of the New York stock market have heard about. Peter Cooper believed that his company's lands were only to be made valuable by the successful development of the railroad project, and he was right, The full recognition of their value is, however, only now being realised after an interval of 60 years.

During this and the following year experiments were made to test the resistance of cars with the Winans anti-friction box and those with hardened steel journals and chilled bearings. With the former the friction on a level, straight road was found to be 1-400th part of the load with the latter 1-240th part of the same. Experiments were also made to test the practicability of turning the street corners of the city with the railroad and cars. It was found that a radius of 60 ft. could be readily turned by permitting the wheels on the outside of the curve to roll on the edge of the flange, which was guided by the flange running in a groove in the rail, whilst the inside or shorter rail remained of the usual form and carried the tread of the opposite wheel.

In his annual report of Oct. 1, 1831, Chief Engineer Knight acknowledged the aid he has received in the arrangement of the machinery from his assistants, John Elgar and Ross Winans, the latter of whom was then engaged in planning the machinery and fixtures for the inclined planes, which was never, however, brought into use. The directors, being desirous of procuring their steam machinery as far as practicable of American workmanship and anxious to direct the mechanical genius of the country to its further improvement, published Jan. 4, 1831, an advertisement for locomotives.

In this advertisement $4,000 is offered for the most approved engine and $3,500 for the next best, the engine to burn coke or coal and not to exceed in running order, the weight of 3½ tons, not inclusive of tender. Three locomotives were offered to the company in response to this advertisement. Of these only one was found to come up to the requirements of the specification. This engine was the "York," built by Davis & Gartnor, York, Pa. It was designed by Phineas Davis, an ingenious watchmaker of that borough, under the stimulus of the company's advertisement and who, probably for the purpose of building it, associated himself with Gartnor, a machinist of the same place. The weight of the engine, limited by the terms of the specification to 3½ tons, was not exceeded. It had a vertical boiler and was carried on four of the ordinary 30-in. car wheels. The size of its vertical cylinders I find nowhere recorded. After undergoing some modifications by which the functions of the cylinders were transmitted to the driving wheels, and velocity attained through spur gearing, the engine was found capable of conveying 15 tons at 15 miles per hour on a level. It was put in regular service between Baltimore and Ellicott's Mills, making the distance of 13 miles in an hour with four cars weighing 18 tons gross. About 5 miles of this distance had a grade of 17 ft. to the mile. It was found to travel curves of 400-ft. radius with facility even at 15 miles per hour and on straight parts of the line sometimes attained a velocity for a short time of 30 miles per hour. The fuel used was anthracite coal, and answered the purpose well, but the boiler was deficient in size. This engine was at once improved upon by the same builders in their engine "Atlantic," which weighed 6½ tons, of which four tons were upon one pair of 36-in. driving wheels. The boiler was much improved. The upright cylinders of 10 × 20 ins. were connected to one pair of driving wheels by spur gearing, doubling the velocity. The new feature was introduced of cutting off steam at two-thirds of the stroke. This engine did good work. It was followed from the same shops by the "Indian Chief," soon afterwards altered and remodeled as the "Traveller," and then by the "Arabian," which latter machine became the type of the so-called "Grasshopper" engine. This engine weighed 7½ tons. The boiler was vertical on the model of that of Peter Cooper, with iron tubes. The cylinders, 12 × 22 ins., were connected through spur gearing, not as in the "Atlantic" directly to the axle of the driving wheel, but to a shaft or axle about three feet in front of the front pair of wheels, parallel therewith and in the same horizontal plane. The ends of this shaft carried cranks which were connected by the usual side rods to cranks on the ends of the driving wheel shafts, thus transmitting the motion to the driving wheels. This arrangement, first introduced into the "Traveller," secured the spur gearing from shocks due to the irregularities of the road and disposed finally of a most troublesome cause of breakages.

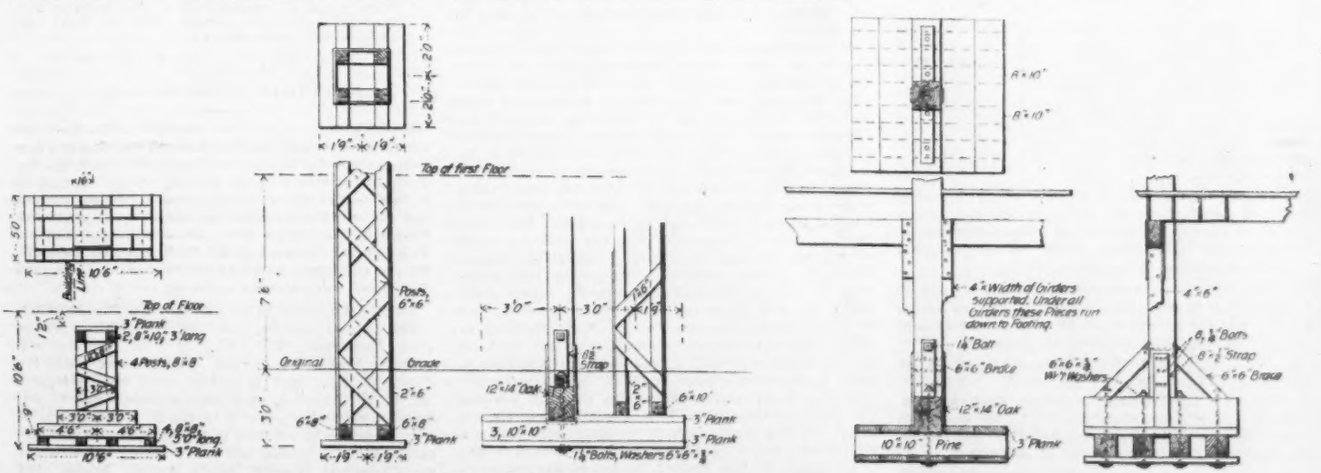
Chief Engineer Knight in his annual report for 1833 stated that the "Atlantic" had run 13,280 miles, burning anthracite coal, of which it had in that distance consumed 190 tons, without the failure of a single tube. The building of these engines was now transferred to the company's shops at Mount Clair, under Phineas Davis as contractor, and the work was there conducted by him until his untimely death by an accident to a new engine he was testing, Sept. 27, 1835. Mr. Davis was succeeded by Gillingham & Winans, who lent their skill to the further perfecting of the machinery and brought these engines to a degree of efficiency which is surprising. So well and so thoroughly was the detail of this engine worked out, and so well adapted was it to hauling heavy loads at slow speeds through curves of the shortest radius, that it has survived to a very recent day. When the late Benjamin H. Latrobe, 20 years ago, prepared for the "Railroad Gazette" a very full and complete description of this engine, it is noted by the editor that four of the engines were still in use. Whether any are in service to-day I am not fully informed, but only a few years ago they were used for yard work at Mount Clair and were very efficient.

(To be continued.)

WORLD'S COLUMBIAN EXPOSITION.

Foundations of the Machinery Building.

In our issue of March 5 we gave an article upon the foundations and floors of the Exposition buildings, showing that after various tests made with loaded platforms it had been decided that upon the sandy bottom, with clay substratum, spread foundations would be of ample stability. This type of foundation has been adopted for the Machinery Building, the plans of which were published last week, and the accompanying drawings represent some of the typical forms of footings. The average load upon the floor is taken at 200 lbs. per sq. ft., this being for the aisles and lighter exhibits, the floors and supports being strengthened under machinery or exhibits of great weight, and under the installation tracks.



FOOTINGS FOR FOUNDATIONS OF THE MACHINERY BUILDING, WORLD'S COLUMBIAN EXPOSITION.

THE REMOVAL OF COL. WM. LUDLOW.

The "Marine Review," of Cleveland, O., gives in a recent issue a statement in regard to the action of the Lighthouse Board, U. S. Treasury Department, in removing Col. Wm. Ludlow, U. S. Engineer Corps, and Commander O. F. Heyerman, U. S. N., from their respective positions as Engineer and Inspector of the Eleventh Lighthouse District, comprising Lake Huron, Lake Superior and the St. Mary's River. If the facts of the case are as stated by the "Marine Review," as to which we have no knowledge, it is certainly rather to the credit of Col. Ludlow that he has submitted to removal rather than carry out the work referred to:

The circumstances connected with the dismissal of Col. Ludlow and Commander Heyerman were as follows: Some two years ago the Lighthouse Board approved a crude plan for lighting the St. Mary's River with 38 lights. This plan was formulated without a close inspection of the river or careful consideration as to the actual number of lights required and their location, it being intended to do this in the customary manner after the appropriation was made and the work ordered. Early this spring Col. William Ludlow, Engineer for the Lighthouse Board in the Eleventh District, was ordered to the Sault River to erect the necessary range lights preparatory to the lighting. Upon getting to work he discovered that the 38 lights would not answer, changes in the channel having been made by the government dredging, which were not taken into account at the time of the original location of the lights. The result of his work led him to adopt a plan consisting of 44 lights, and under the modified scheme, by reason of the increase of lights on the shore and doing away with certain piers near the channel, the cost of establishing the whole system, consisting of 44 lights, was about $1,000 less than that required to build under the 38 light plan. Col. Ludlow reported this to the Lighthouse Board, but was instructed that the 38-light system must be adhered to. To this he protested, but without avail. The Board instructed Commander O. F. Heyerman, Inspector Eleventh District, U. S. N., to visit the Sault River and confer with Col. Ludlow in regard to the lights, the result of which conference was a united protest by both of the district officers, Ludlow and Heyerman, to the Board against carrying out their orders to erect only 38 lights as directed by the Board. This protest was of no avail with the Board, who ordered them to proceed with the work as directed. To this the Engineer and Inspector, who were on the river, signified a willingness to put up such of the 38 lights as would not be misleading to navigation, but declined to erect those which if followed would carry boats away from the channel of the river and onto the rocks. The location of the ranges thus brought prominently

into dispute, and which the officers declined to erect, were certain necessary ones at the "Black Hole" and Topsail Island, two of the most dangerous places, as every Lake Superior sailor knows, on the Sault River. In reply to the stand taken by Col. Ludlow and Commander Heyerman the Lighthouse Board relieved them from their duties and ordered them to report at Detroit and await the arrival of their successors.

Asphalt deposits are reported to have been discovered at St. Jo, Tex., 75 miles northwest from Ft. Worth.

A Krupp gun weighing 150 tons is expected to be one of the sights at the Columbian Exposition. It will apparently be somewhat of a task to distribute this load on cars in such a manner as not to bring an unprecedented load on trucks and bridges.

An ordinance providing for the construction of a new double subway tunnel, for vehicle traffic only, under the Chicago River, is before the aldermen of that city. The total length of the subway would be about 3,200 ft. It is proposed to make each division of the subway 22 ft. in width. One division would be used by trucks and all heavy vehicles; the other, which would connect the park systems of the North Side and the South Side, would be reserved for carriages.

To prevent efflorescence on brick work or remove it when it occurs, a writer in "The Builder" recommends either weak hydrochloric acid or a solution of common salt. The latter he claims to have used with much success, either dipping the bricks into the brine before laying, or thoroughly washing the face of the wall with it after completion.

Borings for a Detroit river tunnel are being made at Windsor, opposite Detroit, by Canadian Pacific engineers, if press reports can be credited.

PERSONALS.

Mr. Torrence E. Crider, County Surveyor of Butler Co., O., in 1882, died at Hamilton, O., June 29, at the age of 37.

Mr. H. H. Colby has been appointed Chief Inspector of Bridge and Track Material of the Pennsylvania R. R., vice Mr. W. H. Hipple.

Mr. G. S. Chapin has been appointed Superintendent of Sewers at New Rochelle, N. Y., and not at Rochester, N. Y., as stated last week.

Mr. J. Q. Baird has resigned as Chief Engineer of the Lake St. elevated railway and resumed his private practice with offices in the Opera House Building, Chicago.

Messrs. O. R. Rauchfuso and A. S. Zinn have a copartnership to carry on a general engineering business, with the firm name of Rauchfuso & Zinn, with offices in the Opera House Block, Joliet, Ill.

Mr. E. J. Pearson has been appointed Principal Assistant Engineer of the Wisconsin Central Ry., with office at the Grand Central Station, Chicago. The engineering office heretofore maintained in Milwaukee has been abolished.

Mr. N. W Fayrs, General Manager of the Wheeling Bridge & Terminal Ry. Co., Wheeling, W. Va., has resigned to accept the position of Superintendent of Structure and Interlocking System of the Terminal Railway Association of St. Louis, Mo.

Mr. J. C. Slocum has opened an office in the Grand Pacific Hotel, Chicago, as a consulting mechanical engineer. Mr. Slocum was until recently the mechanical engineer of the World's Columbian Exposition.

Mr. Chas. F. Stowell, M. Am. Soc. C. E., Mr. A. C. Cunningham, Assoc. M. Am. Soc. C. E., and Mr. M. G. Clay, have organized the American Engineering & Inspection Association, of Albany, N. Y., for the supervision of structural work, and the inspection and testing of structural and railway material of all kinds.

Mr. John H. Snyder, at one time Superintendent of the Albany Iron Works, Troy, N. Y., died June 26 at St. Louis, Mo. While superintendent of the Albany Iron Works he had supervision of the rolling of the plates with which Ericsson's monitor was built. He was the inventor of a number of railway devices, and after leaving Troy he was Superintendent of the Tredegar Iron Works, Richmond, Va.

Mr. William G. Raymond, C. E., of San Francisco, Cal., has accepted the chair of geodesy, road engineering and topographical drawing in the Rensselaer Polytechnic Institute. Mr. Raymond is a graduate of Washington University, and was formerly instructor in civil engineering in the University of California. He has had varied experience in all kinds of railway work and has lately been engaged in general engineering in San Francisco. Prof. W. LeConte Stevens will return to this country in August to take the chair of physics in the same institution.

NEW PUBLICATIONS.

JULY MAGAZINES.—In "The Forum," President A. A. McLeod, of the Philadelphia & Reading R. R., writes on "The Coal Supply and the Reading Leases." He says that the Reading system proposes to bring the products of its territory "home to the consumer upon surer and better terms," a statement of delightful ambiguity. In the next sentence he adds that "it will assure to the thousands of investors in the Reading securities their undoubted right to some return for their money invested. In this will be found a complete explanation of the motives of the management in negotiating the leases." Following this he makes the statement that "it is a mistake to suppose that there is or has been recently any material or substantial competition between the transportation lines as to the carriage of anthracite coal." It is impossible to get much that is satisfactory out of Mr. McLeod's statements, as he deals so much in glittering generalities. As near as we can make out, however, President McLeod designs to put a stop to the evils of over-production, and "prevent the inadequacy of prices," assuring his readers that no unreasonable advance or unreasonable profit will or can be made on anthracite coal. But the burning question which Mr. McLeod does not answer is who or what is to determine what is a reasonable price and what is an unreasonable profit? The movement for uniformity in state legislation, which has already made considerable progress, is described by Prof. Jas. L. Colby, of Dartmouth. He might have added to his paper with advantage something on the need of uniformity in state railway legislation. A reply to S. C. T. Dodd's defense of the Standard Oil Trust is made by Roger Sherman, Esq., of Titusville, Pa., counsel for the Petroleum Producers' Association. He answers very effectively Mr. Dodd's claim that the Trust has reduced prices to the consumer, showing that the reduction of price from 1862 to 1872, before the formation of the trust, was 30%; in the ten years following, during which competition between the Trust and its competitors was sharp, the decline was 60%; and during the past ten years, while the Trust has had things practically its own way, the reduction has been but a trifle over 1% on export goods and practically nothing to the American consumer.

In the "North American Review," Col. H. S. Haines, President of the American Railway Association, tells again what the railways have done in the introduction of automatic brakes and couplers, and argues against legislation on the subject. The "Popular Science Monthly" resumes its series on "The Development of American Industries Since Columbus" in an article by Mr. Geo. A. Rich on "Leather Making." Another paper in the same magazine deserving mention here is one on "Kindergartens and Manual Training," by Mrs. H. M. Plunkett.

Scribner's has a very good article by Samuel Parsons, Jr., on the laying out of small city parks. He states the principles to be followed to secure the most artistic effect and gives practical hints as to the best trees and shrubs to be planted, recommending especially the California privet, American thorns and Thunberg's barberry. Prof. N. S. Shaler describes "The Depths of the Sea" and the animal and vegetable life which is found there. It is an interesting fact that the temperature of the ocean depths is practically the same, close to the freezing point, in arctic and in tropic seas. The "Century" contains the second of Mr. Van Brunt's articles on "Architecture at the World's Columbian Exposition." He writes, however, rather from the standpoint of the artist than of the engineer. In one sense this is the most important standpoint, for it is the one on which failure was most feared. It is gratifying to find in these articles renewed assurances that all fears on this head are needless, and that the Exposition is likely to surpass all others in artistic beauty and unity as well as in material grandeur. The "Century" has also the third installment of Mrs. Mary Hallock Foote's novel, the plot of which turns on the rivalry between an engineer and a "promoter" over a Western irrigation scheme. In this number the son of the promoter, who is a young engineer without practical experience, refuses the offer of his father to make him principal assistant engineer of the scheme, except on condition that the chief engineer shall be as free to discharge him as he would be to discharge any other man's son. We fear the young engineers, or old ones either, who scorn the aid of a personal or political "pull," and insist on standing on merit alone, are rather scarce in real life in these degenerate days. It is fair to say, however, that the young engineer of Mrs. Foote's story had reasons which were not purely professional for his refusal to have his services forced on the chief engineer.

THE ARITHMETIC OF ELECTRICITY.—A Manual of Electrical Calculations by Arithmetical Methods. Including numerous rules, examples and tables in the field of practical electrical engineering and experimenting. By T. O'Connor Sloane, Ph. D., New York: N. W. Henley & Co. 12mo., pp. 138; 8 engravings, 15 tables, $1.00.

The purpose and nature of this work is sufficiently indicated by the above title and description. We have not felt bound to review it in detail beyond the first four lines, wherein we are told:

"Space is the lineal distance from one point to another." "Force is any cause of change of motion of matter."

Primary definitions so careless as these of words which have been carefully defined over and over again do not encourage one to review the rest of the work very seriously as a contribution to science; but for the purpose aimed at in its compilation, it may perhaps be sufficiently accurate and sufficiently scientific.

GEOLOGICAL SURVEY OF TEXAS.—Second Report of Progress. J. E. Hollingsworth, Commissioner; E. T. Dumble, State Geologist. Pamph., pp. 91. Bulletin No. 2. Preliminary Report on the Soils and Waters of the Upper Rio Grande and Pecos Valleys of Texas. By Prof. H. H. Harrington. Pamph., pp. 26. Bulletin No. 3. Reconnoissance of the Guadalupe Mountains. By. R. S. Tarr. Pamph., pp. 42.

The Progress Report of the survey deals largely with recent investigations of the stratigraphical geology of the state, and is made up of the several reports of the different members of the staff. Mr. W. F. Cummins has an interesting report on the Staked Plains, in which he concludes that it is extremely improbable that artesian water can be had on the Plains, although water sufficient for all ordinary purposes may be obtained from shallow wells, or from deep wells by pumping, from streams, and, in the canyons, from springs. Mr. J. A. Singley gives a brief description of the strata pierced by the deep well boring at Galveston, which is 2,920 ft. deep.

The Report on the Soils and Waters of the Upper Rio Grande and Pecos Valleys sets forth the results of chemical examinations made to determine the feasibility of irrigation in those regions, which is proven so far as chemical examinations go.

The Reconnoissance of the Guadalupe Mountains was made to determine their age and some facts regarding the artesian water supply of the plains. Unfortunately the investigations of Mr. Tarr were not carried far enough to enable him to express more than tentative opinions on this subject; but some information regarding the geology of the region was obtained and is presented in the report.

THE OFFICIAL RAILWAY LIST.—A complete Directory of the Presidents, Vice-Presidents, General Managers and Assistants, General and Division Superintendents, Chief and Assistant Engineers, Secretaries, Treasurers, Auditors, Traffic Managers, General Freight, Passenger and Ticket Agents, Baggage Agents, Superintendents of Telegraph Purchasing Agents, Fuel Agents, Car Accountants, Superintendents of Motive Power, Master Mechanics, Master Car Builders, Master Car Painters, Foremen of Repairs, Roadmasters, etc.; of the Railways of North America. Chicago, 1892; The Railway Purchasing Agent Co.: oblong, 8½ × 4½ ins.; pp., LXXIV + 342; price, $2.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF CINCINNATI.—The subject for discussion at the June meeting was that of a new water supply for the City of Cincinnati, which was appropriate at this time on account of the election to be held soon to vote on an appropriation for the purpose and the new Water-Works Commission to be appointed. Papers on the subject were prepared by Col. Latham Anderson, G. Bouscaren, H. D. Burke and John W. Hill, of Cincinnati, and Edward Flad of St. Louis, and the subject was generally discussed.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The summer meeting was held at the Hotel Champlain, Bluff Point, N. Y., June 28 to 31. The first session was held on the evening of June 28, at which the President, Mr. John Birkinbine, and the Secretary, Mr. R. W. Raymond, made brief addresses, and an address of welcome was made by Mr. F. S. Witherbee, of Port Henry, who referred to the development and importance of the mining and iron working industries of the Champlain District, where electric lighting and power drills were first employed in mining operations. Mr. Birkinbine, the President, then read an interesting paper on the pig iron industry of the United States, giving a general statistical and historical review of its development, present condition and prospects, and accompanied by tables, showing the production of Bessemer pig iron, and of all kinds of pig iron, for the years 1887 to 1891 in various states and districts, the totals of which, for the United States as a whole, we summarize in the following table:

	Pig Iron (net tons).		P. c.
	Bessemer.	Total.	Bess.
1887	3,220,517	7,187,206	44.81
1888	2,954,402	7,268,507	40.65
1889	3,529,584	8,516,079	41.45
1890	4,583,424	10,307,028	44.47
1891	3,888,853	9,273,455	41.94
Increase 1891 over 1887	668,336	2,086,249	
Percentage of ditto	20.75%	29.05%	

Prof. Raymond, Secretary, then read memoirs on the

late T. Sterry Hunt and Wm. P. Shinn, members of the Institute, and Dr. James Hall, State Geologist of New York, exhibited specimens of a geological map of the state, which is being prepared under his supervision. When published, blank or uncolored spaces will be left to indicate the areas whose geology has not been determined, so that geologists can see where investigations should be made, and thus enable the map to be gradually filled in and completed.

On June 29, the members and guests left Bluff Point at 9 a. m. on a special train provided by the Delaware & Hudson Canal Co., and proceeded as far south as Port Henry, 55 miles, traversing the most interesting part of the Lake Champlain Division of the road, with its numerous curves, rock cuts and bold work along the cliffs, following the shore of the lake at a considerable height above the water. From Port Henry the party was taken across to Fort Frederic, on Crown Point, by the regular steamer "Vermont," of the Champlain Transportation Co., on her way down the lake, and after a pleasant stroll around the ruins and ramparts of the old fort, which was built by the French in 1731, luncheon was served in a pavilion on the grounds by the courtesy of Witherbee, Sherman & Co., and the Port Henry Iron Ore Co. At 1 p. m. the Port Henry Steam Ferry Co.'s twin screw ferry boat, which has a screw at each end like some of the new Hudson River ferry boats at New York, carried the party back to Port Henry, whence the special train was taken over the Lake Champlain & Moriah R. R. to Mineville. The road has very severe grades, the maximum being about 4%, and several switchbacks, and the train of four cars was hauled by two heavy Baldwin mogul engines, one at each end. The principal points of interest visited at the Mineville works were the central power plant for hoisting, the ore workings, the Bleichert cableway or conveying tramway (built by the Trenton Iron & Steel Co., Trenton, N. J.), and the magnetic ore separator. There are 20 openings into the Bessemer and 12 into the non-Bessemer ore bodies, and these are worked by the Port Henry Iron Ore Co., and Witherbee, Sherman & Co. Over 10,000,00 tons of iron ore have been taken out, of which 2,000,000 tons have been shipped during the past five years. The train left at 4:15 on the return trip and arrived at Bluff Point at 6:30 p. m. The weather was delightful and the trip enjoyable in every way.

At the meeting in the evening Dr. C. B. Dudley read a paper on specifications for iron and steel, in which he referred to the appointment of committees by other engineering societies to report upon uniform tests for metal structural material, and to the friction between producers and consumers, much of which he said is due to bad specifications. The object of a specification is first, to tell the producer what the consumer wants; and, second, to serve as a contract between and equally binding upon both these parties. The principal difficulty is in obtaining the necessary information to make a workable specification. The information may be obtained in six ways: 1, study of the material; 2, experiments with the material in service; 3, consultation with the users of the material in service; 4, examination of material which has failed in service; 5, examination and test of material from various makers; 6, visits to various works. In considering the results of material in service it must be remembered that a good or bad showing may be due to favorable or unfavorable conditions rather than to the inherent qualities of the material. Reference was made to various tests made by Dr. Dudley in regard to rails, tires, springs, bearing metals, etc., for the Pennsylvania R. R. Samples for test should be selected by a representative of the consumer, and selected after shipment, or by an inspector at the works, who must see the shipment made before he leaves. There should be no average samples, but the one selected at random should represent the shipment. As to the close limits of specifications for such matters as ultimate strength, etc., he thought such limits unnecessary in view of the universal use of a factor of safety, and again, large rejections are sometimes made owing to test pieces just failing to meet the specified requirements, while as a matter of fact there is necessarily a certain range of error in all testing experiments. In the preparation of standard specifications for the Pennsylvania R. R. this is fully borne in mind. An inspector at the works should have no discretionary power. Before the final completion of the specifications there should be a consultation between the consumer and the producer, as this will tend to avoid trouble afterward, and has often led to very important improvements in the specifications.

Mr. Axel Sahlin then read a paper on "The Granulation of Iron Ore by Means of Crushers and Rolls," in which he favored the former method, and Mr. W. H. Hoffman followed with a paper on "The Late Discovery of Large Quantities of Magnetic and non-Magnetic Pyrites in the Croton Magnetic Iron Mines." These two papers opened up considerable discussion on the general question of granulating and separating devices, particularly in regard to the Sturtevant mill used by Mr. Hoffman, in which the ore is crushed by attrition upon itself. There was much said as to the respective merits of crushers and rolls, but the general impression seemed to be in favor of rolls, provided that the ore is delivered dry. Otherwise it is much more difficult to treat, and is liable to clog and jam. Mr. Sahlin advocated Hadfield steel for the jaws of crushers, but other members had had better results with cast iron than with this steel, and Dr. Raymond referred to the successful use of soft wrought iron in one case.

On June 30 the party left at 8:30 a. m. on a special train over the Delaware & Hudson R. R. for Plattsburgh, at which point they boarded another special train on the narrow gage Chateaugay R. R., which had been provided by the courtesy of the Chateaugay Ore & Iron Co., and which carried them 74 miles through the celebrated scenery of the Adirondack Mountains. A stop was made at Lyon Mountain, N. Y., which is the mining town of the Chateaugay Ore & Iron Co., 34 miles west of Plattsburgh, and having a population of 2,500. Here are located the Bessemer ore mines, which have a capacity of 400,000 tons per annum, and the concentrating plant, which is capable of treating 1,000 tons per day. The plant at the separator includes roller crushers, Blake multiple jaw crushers and water jigs. The company owns 130,000 acres of mineral and timber lands, and has two charcoal furnaces capable of producing 18,000 tons of charcoal pig iron per annum, and 34 forge fires for the production of steel blooms and billets. The road has a gage of 3 ft., and its track is of commendable excellence, a large part laid with 30-lb. steel rails and angle bars, in good line and surface, making an easy riding track even at the speed (74 miles in 2½ hours) at which the return trip was made. The curvature is very severe in places, and there are numerous heavy grades. Several charcoal kilns were seen along the line, generally surrounded by a wasted and desolate area, covered with stumps, stones and brush where the forest had been cut down to supply charcoal. Near Wolf Lake the line turns south, and from thence to Saranac the new line of the Adirondack & St. Lawrence R. R., now under construction, practically parallels the Chateaugay R. R., and the track is being laid with heavy steel rails and six-bolt angle bars. The terminus of the Chateaugay R. R. is at Saranac, whence four-horse stages took the party to the Ampersand Hotel, one mile distant, at the foot of Lower Saranac Lake, where a good dinner was enjoyed, after which the party drove back to the station, and left at 4 p. m., arriving at the Hotel Champlain soon after 7 p. m.

At the evening session Mr. C. M. Ball presented drawings of a new pulverizer, which is practically a face grinder, a vertical grinding wheel revolving with the outer part of its face at a certain small distance, varied according to the fineness of product required, from a fixed grinding head. From the hopper the ore is led to the center of the grinding chamber, where it is whirled around by radial ribs in the concave boss of the grinding wheel, and thus largely ground by attrition upon itself before passing out between the grinding faces, which are formed with steps or grooves to give the grinding action. This opened the way again to further discussion on separating and concentrating plants, during which many very conflicting figures, by various experts, were given of the power required to drive a certain Sturtevant grinding mill. Mr. Kent thought the Institute, as a jury, should accept all the figures as true, and try to find out some reason for the discrepancies, which he thought would be largely in the "general cussedness" of machinery, as numerous variable circumstances, such as speed, size of feed, etc., will cause very considerable differences in recorded results. Mr. Platt referred to the great variations of power in a rolling mill, according to the work being done, and the same conditions would largely apply in a crusher. A paper by Mr. F. H. McDowell on "Magnetic Concentration at the Tilly Foster Mill," was read by title, and Mr. Harvey S. Chase then read a paper on "The Chase Magnetic Ore Separator," and one of his machines was on exhibition in the hotel, as noted below.

On July 1, a large party took an excursion up the lake on the regular trip of the steamer "Chateaugay" by the courtesy of the Lake Champlain Transportation Co. This trip afforded many beautiful views of the lake and mountain scenery. A through truss, center pier, highway drawspan, operated by one man, was an interesting feature of the bridge to Hero Island. An interesting social accompaniment of the trip was the presentation to a "new made bride" of a photograph and a souvenir spoon, which were subscribed for by the members of the party and presented by Prof. Raymond with a humorous and appropriate address. Later in the afternoon there was a brief meeting at the hotel, at which some further remarks were made upon separators, and a vote of thanks passed to the railway and steamboat companies which had extended the courtesies of special trains, free transportation on excursions, etc. The meeting then adjourned. In the evening there was a dance, and on July 2 a number of the members visited the Ausable Chasm, which is an eastern representation of the great canyons of the West. The lower part is traversed by boats, an exciting trip including the running of three rapids. The Keeseville, Ausable Chasm & Lake Champlain R. R. crosses the chasm by a cantilever bridge with iron piers, built in 1800 by the Berlin Iron Bridge Co., of East Berlin, Conn.

The following were the papers on the list for presentation at the meeting: "The Granulation of Iron Ore by Means of Crushers and Rolls," Axel Sahlin; "The Chase Magnetic Separator," by Harvey S. Chase; "Magnetic Concentration at Tilly Foster," F. H. McDowell; "The Late Discovery of Large Quantities of Magnetic and Non-Magnetic Pyrites in the Croton Magnetic Iron Mines," W. H. Hoffman; "A Modern Plant for the Precipitation of Gold from Chlorine Solution by Sulphurous Acid and Hydrogen Sulphide," Werner Langguth; "The Marsac Refinery, Park City, Utah," C. A. Stetefeldt; "Copper Crystallizations at the Copper Glance and Potosi Mine, Grant County, New Mexico," C. H. Snow; "Note on the Use of a Mechanical Stirrer for Promoting Chemical Action in Phosphorus Determinations," E. K. Landis; "Plain vs. Corrugated Belts for Vanners," Otto F. Pfordte; "The System of Filling at the Mines of the Minnesota Iron Co., Soudan, Minn.," D. H. Bacon; "Notes on a Collection of Tertiary Fossil Plants from Potosi, Bolivia," N. L. Britton.

The exhibits were very interesting, though not numerous. The Thomson-Houston Electric Co., of Lynn, Mass., had a small electric motor driving a Goulds triplex pump (Goulds Mfg. Co., Seneca Falls, N. Y.) and a Chase magnetic separator, and had also an electric hoist in operation. Large numbers of these hoists are said to be in use for various purposes, including wharf hoists for unloading vessels, and the suggestion was made that they might be applied to pile driving. They are easily handled and very readily controlled by means of a rheostat and a friction brake. The Chase separator, manufactured by the International Ore Separating Co., is an interesting machine for separating into various degrees of fineness iron ore which has been crushed for this treatment. In a later issue we shall give particulars of the operation of the machine.

The Hotel Champlain is a large and well managed house, beautifully situated above the shores of the lake, and proved a most satisfactory place of meeting. It is on the line of the Delaware & Hudson Canal Co.'s railway, 164 miles north of Albany, and 307 miles from New York. The railway is principally single track, but has some double track near Saratoga, and double tracking is in progress north of Whitehall. The rail joints are spliced with four-bolt angle bars, but on the double track portion six-bolt angle bars are used. The bold and heavy work along the shore of Lake Champlain has already been referred to. The excursions were the principal feature of the convention, but included places of engineering as well as general interest, and these visits to works and mines and the general discussions and conversation which they give rise to are almost as valuable as the presentation of papers and the more formal discussion thereon. With the exception of a wet trip to Saranac, the weather was fine and pleasant, and the meeting was thoroughly successful and enjoyable.

The next meeting will be held in October at, or near, Philadelphia.

COMING TECHNICAL MEETINGS.

WISCONSIN POLYTECHNIC SOCIETY.
July 11. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
July 11. Secy., C. L. Annan.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
July 14. Secy., Edward Mead, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTHWEST.
July 14. Secy., O. H. Landreth, Nashville, Tenn.

MONTANA SOCIETY OF CIVIL ENGINEERS.
July 16. Secy., F. D. Jones, Helena.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
July 21. Secy., C. F. Franson, 118 Adams St.

ENGINEERS' CLUB OF CINCINNATI.
July 21. Secy., J. F. Wilson.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Aug. 5. Secy., E. K. Smoot, 908 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Aug. 5. Secy., O. von Geldern, 519 Market St., San Francisco.

SWEDISH ENGINEERS' CLUB.
Aug. 6. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
Aug. 6. Union Station, St. Paul.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 18. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3. 1122 Girard St. Secy., L. F. Rondinella.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York.

WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., R. N. Clark, Pittsburg, Pa.

ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.

CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Meehan.

ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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VOL. XXVII. THURSDAY, JULY 7, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: one year, $5.00; 6 months $2.50; 4 months, $2.00; single copies, 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses. No club rates allowed.

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Further experiments in "rain making" are provided for in the Agricultural Appropriation Bill, the appropriation being $10,000. It does not seem to have occurred to the legislators at Washington that the severe rains and floods which have visited the West this spring have, perhaps, been the belated result of General Dyrenforth's explosions in Texas and Melbourne's perspiration in Kansas last fall. This tampering with the weather is risky business, and in view of this spring's revelations of the possible consequences would it not be as well to suspend the experiments for a year or two until the effect of those already tried has worn itself out? What a spectacle we present to the rest of the civilized world by our rashness in repeating experiments which have brought on terrible floods a year after they were tried!

The recent bursting of several dams in Pennsylvania following after the still vivid memory of the Johnstown disaster again suggests the necessity of efficient public supervision of such structures in that state and in all others where such supervision does not now exist. To our knowledge only two states, Connecticut and Rhode Island, have any approach to a systematic regulation of the dams and reservoirs within their limits. The small state of Rhode Island has for ten years employed a Commissioner of Dams and Reservoirs to look after these structures in that state, and Connecticut for some time has had regularly appointed engineers to give a somewhat limited attention to the same subject, when called upon to do so. In other states defective structures must be condemned by courts, county commissioners, or similar bodies, after complaints have been entered, as menaces to health before their condition is improved, and even then the remedy is likely to be neither safe nor sure. Three Philadelphia papers, the "Ledger," "Record" and "Inquirer," the Pittsburg "Dispatch" and, we believe, some other Pennsylvania organs, have spoken out for public regulation of the dams in that state. In our issue of Aug. 24, 1890, the laws of Rhode Island and Connecticut regarding dams and reservoirs were reviewed at some length, and comments were made upon the regulations or lack of regulations in some other states. In our issue of April 12, 1890, the Connecticut law was given in full and commented upon briefly. In every state wise action on this question should be had, or dam disasters may be expected to recur at intervals. As they are apt to be terribly destructive, it is strange that so little effort should be made for reasonable protection.

The letter ballot on new M. C. B. standards this year refers to but two questions, and those of minor importance. They are the proposal to change the form of standard guarantee for cast iron wheels so that wheel makers, who are now not responsible for wheels "flat by sliding," shall not be responsible for wheels "flat or comby by sliding." The only possible objection to this is that it is very hard to distinguish between a "comby" wheel, by which is meant a defect consisting of a network of fine cracks covering a small area of the tread, and a "shelled-out" wheel, which is supposed to be due to a certain lack of homogeneousness in the chill, and in which a hollow with a raised center forms on the tread. It is a well known fact that this defect rarely develops except in wheels of good quality which have made a good mileage. The "comby" wheel, if neglected, will soon form a hollow through the breaking out of the cracked pieces of the tread. Probably there will be a doubt in many cases as to whether the wheel with one of these circular hollows did really "shell out" from a flaw or was made "comby by sliding." As the railway company is the final arbiter, however, it can and probably will decide in its own favor in case of doubt. The only effect of the amendment, therefore, is to give the car-wheel maker his just due for wheels which certainly fail through no fault of his. It is a pity the Association did not go one step farther in the way of doing justice to the wheel makers and adopt the suggestion of its own committee that the cost of wheels failing from worn flanges should be shared equally by the makers and the user. The best attainable evidence is that in the great majority of cases this defect results solely from some imperfection in the truck or in the matching of the wheels.

The other standard on which a letter ballot is to be taken is the coupler gage authorized by the Executive Committee and already in use by the coupler makers. The letter ballot upon this is merely a matter of form.

The lesson that it is not only human to err but human to be forgetful and careless, is one which the average daily newspaper editor is slow to learn. His indignant amazement that any one's vigilance should ever sleep breaks out afresh whenever some unlucky operator at $45 a month forgets himself and wrecks a train, as if such carelessness could only happen from exceptional depravity. The New York "Tribune" thus comments on a notable recent instance of such carelessness:

> The collision between two trains of the Pennsylvania Railroad at Harrisburg, by which 10 (12) persons were killed and more than 70 persons injured, was like many other similar occurrences, in that it was not, properly speaking, an accident, but a crime, for which an employee of the railroad seems to be wholly responsible. No fresh moral can be deduced from this awful disaster. It is simply the blind, stupid and criminal carelessness of one man, against which the most carefully managed system in the world cannot always protect itself. The public demands that such carelessness shall be sternly punished.

Calling such forgetfulness a "crime" is the baldest nonsense. It is merely human weakness. The Pennsylvania Railroad, perhaps, deserves to be called "the most carefully managed system in the world." At least, if it does not, we do not know what system does; and yet, the simple truth of the matter is that this accident is merely a fresh evidence that the block system in use on that road is defective, in that it provides no check against any signalman's sending two trains together on the same track because he has forgotten that one of them exists. This danger has been long known to be a real and great one, and by none better than the officers of the Pennsylvania road, which has had many practical evidences of the fact, one of which (the Meadows disaster) happened six or eight years ago just out of New York, and was nearly as fatal as this last one at Harrisburg. We do not say that the company is therefore blameworthy. The road which was so far in advance of all others in introducing the original block system into this country may well be pardoned for being a little slow in introducing the latest wrinkles; but if there is blame anywhere for this occurrence it rests with the company rather than with the operator, for the simple reason that human nature is not equal to the strain of perpetual "present-mindedness" in a position like a signalman's, and approved checks against such lapses have long existed in extensive use. Another reason why such checks are needed is that on every large staff there must be a certain proportion of raw, green youths just learning their duties, by substitute service and the like, as was the operator in this case, and such men are more easily confused and cannot be expected to appreciate fully the danger of "supposing" and taking chances.

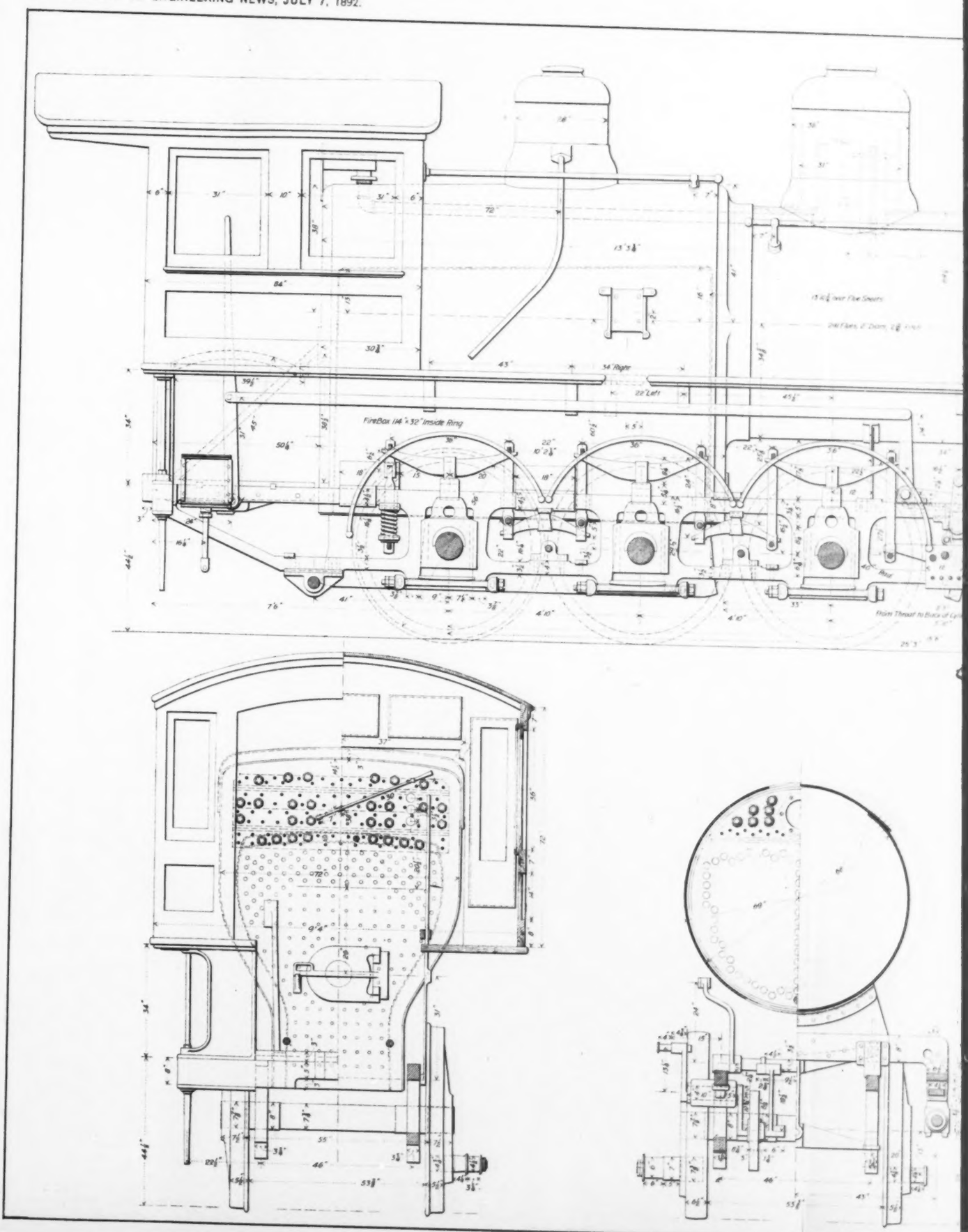
One of the most important papers which appears in this issue is that by Professors Denton and Jacobus on the performance of refrigerating machines, in which they show, what will doubtless surprise many of our readers, that a pound of coal used to make steam for a fairly efficient refrigerating machine can produce an actual cooling effect equal to that produced by the melting of 16 to 46 lbs. of ice, the amount varying with the conditions of working. Or, to put the same facts differently, 855 h. u. per lb. of coal converting into work in the refrigerating plant (at the rate of 3 lbs. coal per HP. hour) will abstract 2,275 to 6,545 h. u. of heat from the refrigerated body. The waste of cold in actual ice-making is such that the production of ice per pound of coal is about half this, or somewhat more if the ice is not made from distilled water. Ice-making is far from being the sole use of refrigerating machines, however; in fact, now that the efficiency and reliability of mechanical refrigeration is proved, it wants only an appreciation of its advantages by the public to bring it into much more extended use than it has yet received.

For example, let us consider the feasibility of cooling office buildings, hospitals, etc., by this system. In a paper on "The Ventilation of Buildings" by Mr. Alfred R. Wolff, M. Am. Soc. M. E., this subject was considered with a view to cooling by the use of ice, over which the air was passed by a blower, as is now practiced in a few theaters. Taking up his calculation in detail, let us estimate the cost of cooling buildings by mechanical refrigeration.

Mr. Wolff allowed 2,000 cu. ft. of fresh air per hour per person as sufficient for fair ventilation. With the air at an initial temperature of 80° F., its weight per cubic foot will be .0736 lb., hence the hourly supply per person will weigh $2{,}000 \times .0736$ lb. $=$ 147.2 lbs. To cool this 10°, the specific heat of air being 0.238, will require the abstraction of $147.2 \times 0.238 \times 10 = 350$ h. u. per hour. These assumptions may be accepted as correct, except as to the temperature to which the air should be cooled. Probably a temperature of 70° in a hot summer day would cause frequent complaints of cold; a maximum reduction of 10° from the external atmosphere is, however, a proper basis to calculate upon, at least for office buildings. Thus the necessary cooling effect calculated by Mr. Wolff may be accepted as correct.

Taking the figures given by Messrs. Denton and Jacobus for the refrigerating effect per pound of coal, as above stated, and the required abstraction of 350 h. u. per person per hour to have a satisfactory cooling effect, the refrigeration obtained from a pound of coal will produce this cooling effect for $2{,}275 \div 350 = 6\frac{1}{2}$ hours with the least efficient working, or $6{,}545 \div 350 = 18.7$ hours with the most efficient working, the ammonia plant being used in either case, and compressed air being much less efficient. With ice at $5 per ton, Mr. Wolff computes the cost of cooling with ice at about $5 per hour per thousand persons, and concludes naturally that this is too expensive for any general use. With mechanical refrigeration, however, if we assume 10 hours' cooling per person per pound of coal as a fair practical service in regular work, we have an expense of only 15 cts. per thousand persons per hour, coal being estimated at $3 per short ton. Of course, this is for fuel alone, and the various items of oil, attendance, interest and depreciation on the plant, etc., must be considered in making up the actual total cost of mechanical refrigeration. But, on the other hand, by the use of the most economical machinery a much higher efficiency than that which we have assumed or than the highest given in the authors' table ought to be possible, as they have allowed a coal consumption of 3 lbs. per HP. hour.

These figures are sufficient, however, to prove the practicability of artificial cooling for office buildings, hospitals, theaters, hotels, and even for the best class of private houses. It is a curious example of the slowness with which people take advantage of modern inventions that thousands of men sit sweltering in hot offices in the midsummer days; business lags and the efficiency of workers whose time is worth many dollars per hour is greatly reduced. At the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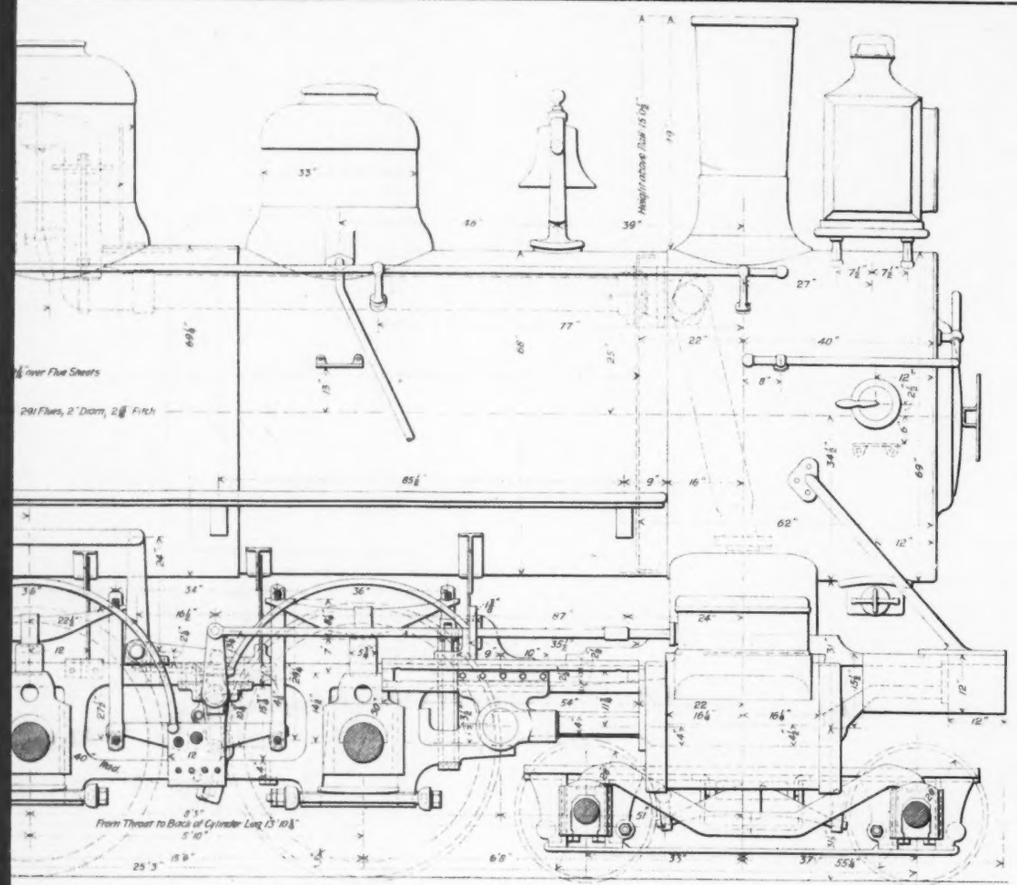
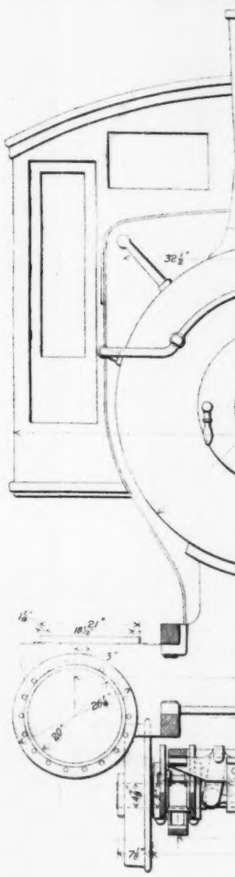
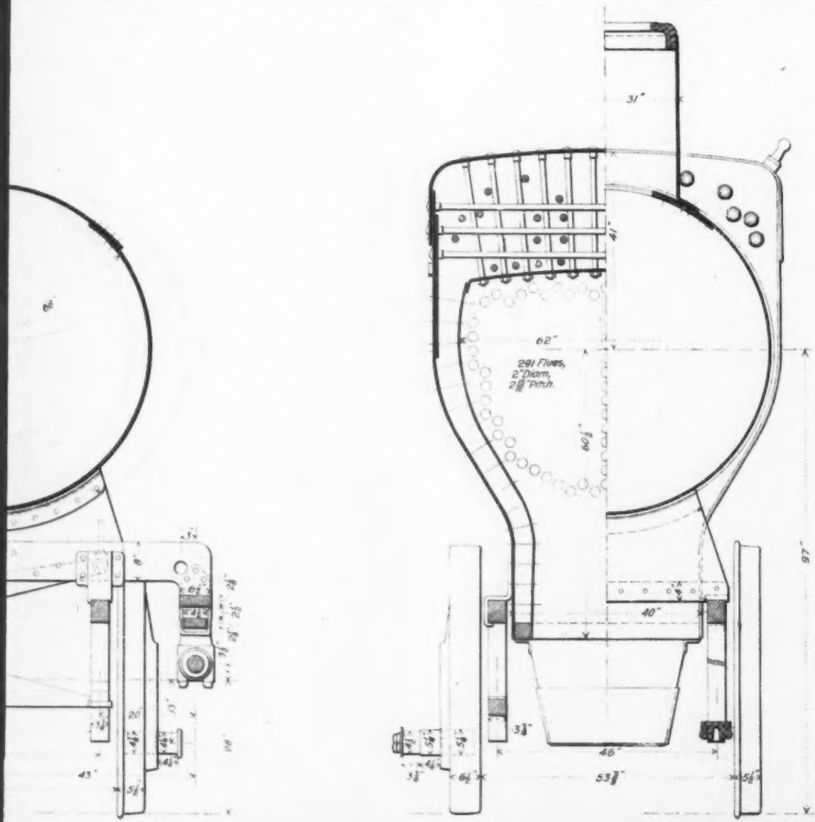


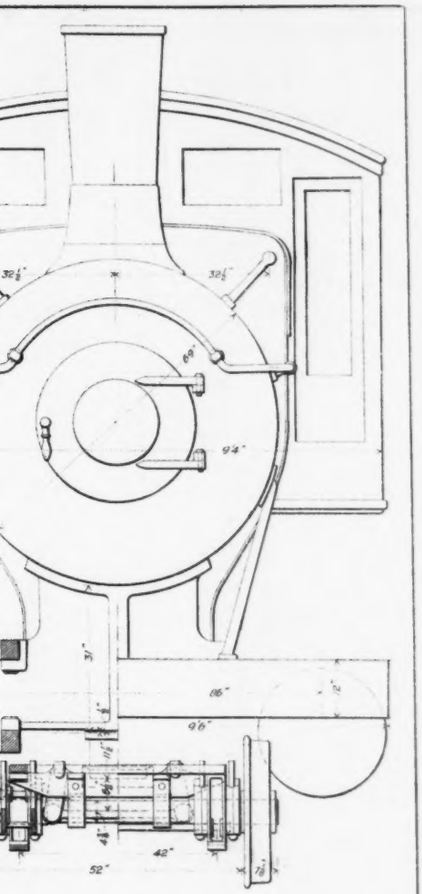




TWELVE-WHEEL, OR MASTODON, FRE

IRON RANGE & HURON BAY

Brooks Locomotive Works, Dunkirk,



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CHAS. HART & SONS, LITH., 35 VESEY ST., N. Y.

same time not more than three or four blocks away are great provision warehouses where the temperature is kept at freezing the year round, and at a very moderate cost. If it pays to keep dead ducks and turkeys cool on Greenwich St., why would it not pay to keep live business men cool on Broadway?

POSSIBLE BRAKING POWER WITH ELECTRIC TRACTION.

In his interesting paper on "Coming Development of Electric Railways," which is abstracted in another column, Mr. Frank J. Sprague makes a true statement which has been often both asserted and denied on mistaken grounds. So far as we can judge, Mr. Sprague himself makes the claim on mistaken grounds. He states that by turning the motors into dynamos when it is desired to stop a fast train, and thus reconverting a part of the energy into electricity instead of destroying it all by brakes, not only is a certain economy promised (which is, of course, true) but that the train could be "more quickly and effectually stopped," which is also true, and which is the question in dispute.

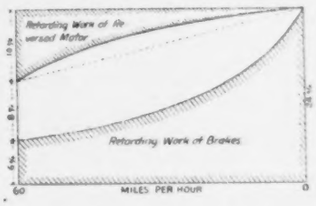
The reasoning by which this claim is often made is plausible, but erroneous. It is in substance that, in addition to the usual retardation from shoe brakes, which is open to the electric train as to any other, the electric train will get the further retardation due to the resistance of the motor acting as a dynamo. The error in this claim, put in this way, is that, as both the retarding forces act on the same axles to prevent their revolving, and as the brake-shoe friction alone is now made as high as is possible without skidding the wheels, we cannot add a new resistance without decreasing the other pro rata. We need hardly say that if the wheels once skid, the retarding force is suddenly and greatly decreased, to about one-third of what it was before. The recognized end and aim of all brake practice, therefore, is to make the brake pressure as great as is practically possible without endangering sliding of the wheels. Of course, to do this in practice it is necessary to leave quite a little margin between the ordinary working shoe-pressure and the skidding pressure; but that margin cannot be safely encroached upon by adding a new retardation any more than it can be encroached upon by increasing the shoe pressure, which latter is a mere matter of leverage and can be made anything one chooses without varying the cylinders or air pressure.

These facts seem to indicate that a reversed motor will not and cannot add anything to the braking power of the train, and the reasoning which leads to this conclusion is certainly more plausible than that first stated, which leads to a contrary conclusion. And yet there is an error in it which is none the less real, though not so obvious. There is a saving fact which does make it possible, both in theory and practice, to add to the full retarding power which can be had from the brakes the full retarding power which can be had from the reversed dynamo, and to utilize the sum of the two resistances in stopping the train, so that an electric train can make considerably quicker stops (assuming always that it is safe and practicable to thus reverse the motors into dynamos) than it is possible for a steam driven train to make.

This saving fact is, that the maximum retarding effect from the brakes comes only at low speeds, and is much less at high speed, whereas the maximum retarding effect of the motor-dynamo comes only at high speed, and becomes a vanishing quantity at low speed, when the brake resistance is at a maximum. Therefore, the two do not clash, and the sum of the two at all speeds is actually available.

In the accompanying diagram we have illustrated graphically the conditions which obtain between 60 miles per hour and a dead stop, and with some approach to a correct vertical scale. There is no particular horizontal scale. The limit of retarding force is that which will stop the wheels revolving, and this is substantially constant at all speeds at 24% of the weight on the wheels. Therefore, if our braking power were maintained at its maximum limit throughout the stop, the distance between the top and bottom lines of the diagram would represent the total retarding work done at all speeds.

But although the coefficient of static friction between a rolling wheel and the rail is practically constant at all speeds, the coefficient of sliding friction between wheel and brake-shoe is by no means constant. At 60 miles per hour it is only about .06, and it slowly increases thence to about .10 at 30 miles per hour, .20 at 10 miles per hour, and .24 to .25 at one mile per hour or less. Assuming the brake-cylinder and brake-shoe pressure to be constant (as it is, except for the leakage which slightly decreases it), the height of the lower shaded area in the diagram represents in magnitude and distribution the maximum retarding force which is obtained and obtainable from the brakes at any speeds in terms of the load on the wheels.



On the other hand, the upper shaded area represents in like manner the maximum retarding force which is obtainable from the reversed motor acting as a dynamo to reconvert energy into electricity. Speaking broadly, and neglecting frictional losses, the maximum retarding effect would be the same as the maximum accelerating effect of the same machine acting as a motor. Now, in railway service few steam locomotives are capable of exerting as much as 50 lbs. per ton accelerating effect upon the trains which they haul, which is only 2½% of the weight, but electricity, which is revolutionizing everything, may perhaps revolutionize this also, and the electric motor of the future limited expresses may perhaps be able to exert as much as 200 lbs. per ton of accelerating force (10½% of the weight), or an equal retarding force when reversed.

But as the speed of the train falls, the speed of the reversed motor will fall also, and the retarding force from it will fall still faster. How much faster we will not inquire. One can hardly predict. If it fell directly as the speed, we should get the dotted line in the diagram as the limit of the upper hatched area. Actually the line must always be (so far as we can now foresee) more or less concave toward the dotted line.

In either case it will be seen that the two hatched areas of the diagram can never overlap each other, nor even occupy the entire height available at any point, except at the very end of the stop. In other words, both retarding forces together can never utilize the entire theoretical braking power, 24% of the weight on the braked wheels. We have assumed a maximum speed of 60 miles per hour for convenience, but we may write in 100, 150 or 200 miles per hour on the diagram in place of it and still the diagram will remain substantially correct. The upper shaded area will be wholly unaffected, and the lower area will be affected only at the left, where it will be a little smaller, leaving a still larger central area of unused braking power between the two. The lowest aggregate of efficiency will be seen to be in any case near the middle of the stop, when the retarding efficiency of the reversed motor has decreased and that of the brake shoes has not very greatly increased.

In order to avoid the loss of braking power at high speeds which has been noted, Mr. Geo. Westinghouse at one time devised an apparatus by which a great excess of pressure could be applied to the brake shoes at first, this pressure automatically decreasing as the coefficient of friction between shoe and wheel increased. In this way he maintained the retarding force constant, instead of the cylinder pressure, and thus maintained the former throughout the stop just short of the 24% which would suffice to skid the wheels. With this apparatus he made experimentally the quickest stops ever made; and were this device in general use the reasoning heretofore used and embodied in the accompanying diagram would fall to the ground, because the lower hatched area alone would then occupy the entire diagram. But this apparatus has never been put into practical use, and is never likely to be, as it sensibly adds to the complexity and cost of the brakes without an adequate return.

So far we have considered only the case of the "emergency stop," in which the full power of the brakes is exerted, in order to stop as quickly as possible. These stops are so rare, however, that so far as any economic question is concerned they may be disregarded. In the ordinary service stops the mean braking force throughout the stop rarely exceeds 4 to 6% of the weight on the braked wheels, nearly all of which might be conceivably supplied by the reversed motor, if as powerful as we have assumed. In any case the percentage of the energy saved in this way would be likely to be much larger than our diagram shows. On the other hand, it would rarely be the case that the motor alone could be relied on to stop a train, since it can only stop a train about as quickly as it gets it under way. Hence, much of the energy must in any case be wasted at every stop.

Finally, in one important department of brake work, graduating a run down hill, a resistance of from 1 to 4% of the weight of train is the most ever required, and this should be all obtained from a reversed motor, if so designed as not to burn out armatures or otherwise suffer injury as an effect of reversion.

The conclusion of the whole matter is that all stops can be made more economically and emergency stops more quickly also by reversing the action of the motor, the full retarding power of the motor dynamo being in all cases utilizable. If so, here is a legitimate field for effort so far as its possibilities of economy are concerned. It rests with the electric experts to devise a motor which shall be conveniently capable of such reversion, without injury to itself or loss of efficiency. When this has been invented, it will be the only kind to use in electric railway service. It has not yet been invented, however, so far as we are informed.

PUBLICATION RULES FOR SOCIETY PROCEEDINGS.

As was stated in the report of the proceedings of the late Fortress Monroe convention of the American Society of Civil Engineers, that body promptly reconsidered and partially withdrew the restrictions upon reports of its proceedings which were established by the circular given in our issue of May 26. Formally, the withdrawal extended no further than to the proceedings of the late convention, but the discussion and vote which followed the president's announcement showed that the extreme position taken by the publication committee was disapproved by the society and management and practically abrogated.

That position was in effect to "insist upon rigid adherence to this rule:" Abstracts will be published in the Society's newly established "Bulletin," and generally in advance of meetings. "Such abstracts may be republished immediately, but no other publication of the papers in advance of their appearance in the 'Transactions' will be permitted. This applies to discussions as well as to the papers themselves." The plain effect of this wording was to prohibit any report of technical proceedings whatever other than what appeared in the advance "Bulletin" or than might (or might not) appear some months later in the "Transactions." It is needless to say that this amounted to a complete reversion of the established practice of the Society in a most important detail of its policy, and it illustrates how such things are sometimes done, that it was developed in debate that the action taken was wholly without the knowledge of the president or of the Board of Direction. It had not even been submitted in advance to all the members of the publication committee. Some weeks or months before the whole subject had been referred to that committee, "with power," and two or three members of that committee had really decided the whole question.

It is indifferent to us what further action in the matter may be had, except that, if we considered only our own comfort and profit, we should earnestly wish that this and all other technical societies would take and stick to the same position. But inasmuch as the question has thus been brought up, and is one which troubles a good many societies, it may be well to say a few words upon it, from the only standpoint which is of living interest to any

human being except the authors of papers, that of the best interests of such societies. We pass the point that as scientific bodies such societies ought to consider only the interests of science. The officers of such societies are, and ought to be, primarily anxious to do whatever will most promote the growth and influence of their own society; and only in the second place, and only so far as it will not interfere with the first, to do whatever will most tend "to the advancement of knowledge among men." They all but invariably hold, and we agree with them, that their first duty is to their own society, and that they are not warranted in imperiling its interest even to "disseminate knowledge among men."

Under these circumstances it is easy to see the arguments which impel to such action as that under discussion. They have a certain prima facie strength, and are in substance these: The society receives and publishes valuable papers. It wishes to receive more. They are published at the expense and for the benefit of the members, and are one of the greatest of the privileges of membership, for which heavy dues are paid. It is not just to those who pay these dues that technical journals should republish the text of these in full or nearly so, and thus scatter them broadcast for the benefit of those who are not members and do not pay dues. Moreover, the effect of such free publication is to deter men from joining the society. Moreover, "advance copies are subject to correction, and often subject to considerable alteration." The member who has been a little too previous, and said something that "hadn't ought to be said," has no chance to quietly wipe it out before the world has heard of it. Moreover, the society has had the trouble and expense of making the engravings, and the technical journals can copy them photographically for next to nothing.

These arguments lead many society officers to disapprove of general publication of papers. The technical editor is disposed to agree with him for quite other reasons. For ourselves, we heartily wish that not only the Am. Soc. C. E., but all the other societies of like nature would adopt an inflexible rule that nothing should be published in regard to any proceeding at any of their meetings, except by way of abstract from their Transactions when published. We should be saved from an onerous, expensive and time-consuming labor without being open to any blame for negligence or lack of enterprise. We could attend meetings for personal pleasure only, or stay away entirely. Whatever we desired to publish could be prepared from the society publications in an hour, where it now takes days. There would merely be some drops less in the bucket of possible "copy" which the wearied editor has to drink weekly. The general public has little idea of the pressure upon all technical journals of any standing in this respect. Our selections may not be always wise. Doubtless they are not, especially in any one reader's judgment, but it would be far easier for us to publish weekly a journal four times as large as we do, so far as "copy" is concerned, than to publish what we do. We have nearly always enough "left over" matter in type to make another paper, and in "copy" to fill three or four papers. There are few volumes, indeed, of society transactions, of which we should or could publish more than half in full, if the original copy were tendered us for our exclusive use.

We have endeavored to state fairly the arguments which favor a restrictive policy. Now as to the other side.

What is the motive of those who write these papers, which are admittedly necessary to the society's success? It may be chiefly a legitimate desire to advertise the author, or to advocate particular views, or to advance the cause of abstract science, or a sense of duty and fellowship, or to make known the success of certain designs or processes. More often, it will be an undefined mixture of all these motives; but in either and any case what the author needs is readers and plenty of them, or he fails of his object. That course which in the end gives him the most readers among the class which he addresses is the course which he will in the end prefer to take; and this fact, under present conditions, works powerfully in favor of the technical societies; because technical journals which are in any sense rivals never copy from each other, while all of them are quite ready to republish or abstract valuable papers read before engineering societies, if reasonable opportunity to that end be given them.

Thus the author of a really good paper may, by reading his paper before a society, reach not only the membership of that society, but also all the readers of four or five technical journals. We have repeatedly had this reason advanced to us for sending such papers to societies instead of giving them to us for first publication, and been compelled to admit that there was a certain force in the argument, at least, if less than the authors supposed.

But now suppose the restrictive policy in question is definitely adopted by any society, what is the effect? The author must then choose between seeing his paper published in some engineering journal and in the society's publications, because the only motive which (barring rare exceptions) leads the technical journal to pay any attention to his paper—to satisfy an immediate curiosity as to its contents while it is yet fresh—has been taken away. The engineering journals get no credit for such republications, but rather discredit for not being purely original; except, indeed, as they do their readers a further service by winnowing the wheat from the chaff (of which there is an immense quantity), and they will and must insist on doing this in their own way, and according to their own judgment. They are overcrowded even with original matter, and still more with "reprint" and "abstract" copy, the quantity of which is boundless, though much of it must be given in a journal which endeavors to keep its readers thoroughly informed as to the progress of engineering.

To illustrate what may be expected by what has happened: Two years ago (Friday, May 31, 1892, at 2:30 p. m.) there was a terrible catastrophe at Johnstown. In our very next issue (June 8) we published the past history of the works in question, and a few days later we had obtained on the ground by camera and survey the materials for an elaborate illustrated record of the engineering features of the disaster in time to publish it complete with numerous maps, sections and views in our issue of June 15. It is safe to say that every reader of this journal read that article through when it appeared, for the disaster was then uppermost in the minds of everyone; and some days before it was published in this journal its substance was transmitted through the Associated Press throughout the country, and read by millions in the daily press, as the first authoritative information from the scene of the disaster as to its real causes.

Some weeks later a committee of three eminent and specially qualified members of the Am. Soc. C. E. was appointed to investigate and report upon the same disaster. Some seven months later their report was submitted, at the Annual Meeting, but with the request that it should be withheld from publication, on the ground that it might affect pending litigation. At the time this was a severe disappointment to us. We were very anxious to see and publish the report. We feel no doubt that it was an exceedingly able and valuable report. It was much more "available" than any paper which the society had published for years, as the public interest was still keen, and we had even more reason than the general public to be interested in it, because it would confirm or confute our own quickly formed and quickly announced conclusions. And yet, so completely does the present overwhelm the past in the mind of the busy editor, that the present writer was not aware until three days since that the report had been published months ago, and he has not at this writing the least idea of what it contains, or whether it confirms or confutes our own conclusions!

If a report on such a subject by such engineers could under such circumstances thus escape attention, what chance is there that the average paper would receive much attention when it finally came out months after it had been read? It is true that a large part of such delay in society publications is mere unbusinesslike shiftlessness and quite unnecessary, but we must take conditions as they are. Societies always have been careless in such matters, and always will be. So would the managers of this journal if they dared to be. It is human nature. This means that a few dozens or hundreds at most will read the papers while they are yet new, if they are to be read only in the society publications. The Am. Soc. C. E., for example, has only about 1,500 members in all, of whom not a baker's dozen have joined chiefly to receive the publications. They join the society largely as the proper thing to do, as an evidence of their professional standing, or from a feeling of good fellowship and professional esprit. Not one in a hundred would be any less anxious to join if there were no formal publications, except through the technical journals, provided of course the dues were correspondingly lower. They value the publications for reference purposes, of course, as one values a text-book or dictionary, but not for habitual perusal. With rare exceptions the members merely file away their copies, and bind them up from time to time to have them handy for reference.

On the other hand, the weekly edition of a successful technical journal is from three to eight times that of any American society publication in the first place; but, in the second place, whatever may be the relative merits and demerits of the two in other respects, the contents of the technical journal have at least the supreme merit of being read, for the very good reason that there is no conceivable motive for any one's taking it if he does not care to read it. It is true that there are a great many technical journals of an inferior grade in this country whose circulation is chiefly free, or they would have none worth mentioning; and it is a surprising fact that in England even the highest grade of technical journals distribute hundreds of copies free to influential readers, as an expected perquisite. But with this journal at least (and the same is no doubt true of two or three other American tecnnical journals), this is not done at all. There is no "free list," but every person is called upon yearly to decide anew whether he really cares to read the paper or not by either (1) paying the considerable sum of $5 annually in advance, or (2) placing a permanent advertisement in its advertising columns. No privilege of attaching any cabalistic initials to one's name is bought with this $5; no privileges of hearing oneself talk at any meetings or conventions or ornamenting one's necktie with any scarf pin; no express or implied obligation to continue paying $5 yearly has been incurred; nothing is lost by ceasing to do so but the bald privilege of receiving and reading the journal weekly. Therefore, we feel safe in saying that that privilege is valued and exercised to a considerable extent by every person who takes the paper; otherwise, he would not take it.

If all these things are so, the true policy for engineering societies would seem to be rather to encourage than to oppose republication in full or in abstract of all papers read before them as soon after their publication as possible. They will not find that any alarming proportion of them will be published in full. Until they improve the artistic execution of their engravings at least, it is quite certain that technical journals will not take that trouble. All our American societies are too careless in this respect, and the Am. Soc. C. E. engravings are still rather conspicuous in their badness, which seems the less excusable because a much better style need cost no more. Before a paper is read, of course, no society can permit its papers to be abstracted without diminishing the interest of its meetings, unless the abstracts are so made as to whet curiosity rather than to satisfy it, as seems to be the case with the advance abstracts so far published in the Am. Soc. C. E. "Bulletin." The technical journals can hardly be expected to permit their space to be thus used for mere advertising purposes, or to resign the right to edit their own columns. And we repeat that, so far as their selfish interests are concerned, they do not care a button what the societies may or may not do about their publications, except that they would rather prefer to have the restrictions rigid, since they must apply equally to all, whatever they are.

A drainage district, including Mason, Menard and Cass Cos., Ill., is reported as having been organized at Havana, Ill. It is proposed to straighten the Sangamon River from Pittsburg to its junction with the Illinois River. It is stated that by the river the distance between these two points is 336 miles, while in a direct line it is but 39 miles. It is thought that the length of the river can be shortened by one-half and 1,500 acres of land per mile reclaimed at a cost of from $3 to $5 per acre.

LETTERS TO THE EDITOR.

THE ROANOKE CITY SURVEY.

Sir: I wish to correct in your next issue some statements made in your issue of June 23, in regard to the official survey of this city. You give more credit to me than I deserve in the work. While I claim that the whole work is very creditable to my administration of the office of City Engineer, and that credit is due me personally for inaugurating and promoting on all possible occasions a work so much needed and which I am now confident will be of almost incalculable value to the city hereafter, I do not claim credit for devising the plan for the survey nor for the methods for executing the plan, nor for the modified plan for house-numbering, except that after consultation all received my sanction and support.

Credit for the authorship of these belongs to my assistant, Mr. Geo. P. Wood, who has proved himself in every respect worthy of so important an undertaking.

Yours truly,
Wm. M. Dunlap, City Engr.

Roanoke, Va., June 27, 1892.

(There is credit enough due for the Roanoke survey to go around among two at least. It is a most excellent and very cheap piece of work. We may note also in correction of one or two minor details of the article referred to that the temperature was taken to the nearest degree, practically, and that the street hubs used were $\frac{1}{2} \times \frac{1}{2} \times 12$ ins. Also the area covered by the survey is somewhat less than 6,000 acres.—Ed.)

TESTS OF SOUTHERN BRIDGE IRON.

Sir: This copy of tests of iron rolled by the Lookout Iron Co., of this city, is from the original furnished to the General Manager, J. D. Roberts, by the Louisville Bridge Co., which made the tests. I know that bridge men generally look on Southern iron as not up to their standard, but I imagine that very few, if any of them, would ask for anything equal to this made here every day.

No. of tests.	Orig'al diam.	Reduced diam.	Reduc. of area.	Elong. in 8 ins.	Elastic limit. lbs.	Elastic limit. lbs. per sq. in.	Breaking load.	Tensile strength.	Fracture.
I	0.22 ins.	0.64 ins.	30.32%	19.5%	14,000	30,000	25,300	54,300	Fibrous Cup.
II	0.82 ins.	0.68 ins.	38.91%	23.88%	18,000	30,300	33,200	55,800	Fibrous Cup.

Yours truly, J. P. Suverkrop.

Harriman, Tenn., May 23, 1892.

AN APPROXIMATE FORMULA.

Sir: The obtaining of the friction head required in the case of water flowing through pipes, by means of Weisbach's formula, is a tedious labor. The same results may be obtained with an exactitude sufficiently near for all practical purposes, by means of the following formula (which does not profess to be scientific, but entirely empiric), in at least one-tenth of the time required to solve the more complicated one of Weisbach.

$$H = .893 \left(\frac{.4\ v \times (v + 1) + \frac{v-2}{10}}{d} \right)^2$$

when H = friction head per 100 feet of pipe, v = velocity in feet per second, d = diameter in inches.

I remain, dear sir, very truly yours,
Wm. Cox.

New Brighton, N. Y., June 2, 1892.

SHORT OR LONG RADII FOR STREET CORNERS?

Sir: I want to inquire if any of your readers interested in municipal engineering can give a good reason for laying out the curbs of sidewalks at street corners with a very short radius, when a long one is apparently so much more convenient for all who travel in vehicles? Pedestrians do not need the corner cut off by a long radius, while it is certainly of great utility in facilitating traffic, and in the prevention of a blockade at the intersection of busy streets to enlarge the throat as much as possible. It is as reasonable to make "crosses" and "tees" of water pipes, or the junction of sewers, with sharp right angles, as to compel the current of traffic on a busy steet to turn too sharp a corner. Among the cities of the Pacific coast the radius of the sidewalk curb at the corners is from 5 to 15 ft., usually 10 ft. or more, while in Denver, Topeka and other cities of the Atlantic slope, I have noticed that the radius used is from 1 to 3 ft., and I observe that where a double-track cable-road turns a corner the inner rail often comes so near the curb that it is frequently necessary to cut off the corner of the side-walk in order to leave room for the ordinary gutter. If a longer radius were used it would be possible for a vehicle to pass between the rail of the track and the curb without the danger of being caught in a contracting "cul de sac" by a swiftly moving car.

If there is a good reason for the continued use of the very short radius, which seems but little better than an abrupt square corner when not exceeding 2 ft., it would gratify me to be enlightened on the subject. Is not this one of the instances where precedents have been blindly followed without intelligent consideration of the comfort of the public? A compilation of the experience and opinions of city engineers on this subject would be of general interest. Jas. D. Schuyler.

Denver, Colo., June 17, 1892.

(The narrower streets of eastern cities have doubtless helped to sharpen the corners of sidewalks, but in New York the usual radius is about 5 ft., we think. A larger radius is, of course, preferable, and in this connection we may notice a frequent error in laying out stairways and short passages through which large crowds have to pass. The entrance to and exits from such contractions should always be well rounded off to obtain the maximum discharging capacity, just as the corners should be rounded off for the discharge of a fluid through an orifice, and for like reasons. With sharp corners the separate particles jam against each other in the effort to enter the passage, so that there is there congestion, whereas in the center of the passageway the space is not half utilized. Any one who will watch a crowd discharging through such a passageway will be struck by the parallel between its behavior and that of a fluid discharging through an orifice.—Ed.)

A CURIOUS MICHIGAN TORNADO.

Sir: A tornado passed about 2½ miles south of this village on Wednesday, June 23, which was apparently of a different character from any of which I have seen any account—enough so, I think, to warrant its being put on record. I passed over several miles of track soon after, and saw its effects, and talked with those who witnessed it. It demolished buildings, uprooted forests of large trees; scattered fences, and performed all the antics of the typical tornado; but the way in which it demolished some things and left others, which were apparently right in its track, was at first incomprehensible. A lady who had a fine view of it, as it passed over the cleared fields, unpleasantly near her house, says that it was a dense cloud "with three tails, which dragged along the ground and whirled around each other," sometimes approaching each other and again separating to quite a distance. If this is true—and other observers say it had more than one branch or vortex—it fully explains the zigzag track it made and how and why some things were taken and others left. Another unusual thing is that all the observers agree in saying they heard no unusual noise with it. A lady who saw it coming retreated to the cellar. It prostrated a large quantity of heavy beech and maple timber, some of it falling within 100 ft. of the house; moved one building, which adjoined the house, 10 ft. or more; demolished several outbuildings within 100 ft. of the house, and she and others with her heard nothing of it and had no suspicion that anything serious had happened till they saw it afterward! In another place a new barn 40 × 80 ft. was apparently lifted in air and then thrown to the ground with such force that it was crushed as flat as if a 1,000-ton roller had passed over it. Other barns and sheds near by were unroofed and the debris thrown in every direction, and yet the man in the house, only a few rods away, from whom I learned these facts, said he did not hear it, and was astonished when the rain abated to see the destruction it had wrought. Another man, who saw the tornado at a distance of a quarter of a mile, said he heard no unusual noise. He described it as "an invisible, silent power, which moved slowly along and was only rendered visible by the falling trees and flying debris." The observers all agree in saying it was not more than two or three minutes in passing a given point. It was accompanied with heavy rain and lightning. Yours truly,

F. Hodgman.

Climax, Mich., June 27, 1892.

FLORIDA PHOSPHATE MINING.

Sir: High grade phosphate was found in Florida less than three years ago, and, although as an industry it is possessed of a promising future, it is still in its swaddling clothes and suffering from innumerable infantile complaints. This discovery inaugurated one of the largest and at the same time airiest booms that the country has ever seen. The great success of the South Carolina phosphate industry, and the very superior grade of the Florida phosphate, furnished grounds for the most unbounded expectations.

Land speculators and real estate agents have had a glorious inning. The most exaggerated ideas prevailed as to the ease with which the phosphate could be mined and prepared, and the profits to be realized. By actual count of the government agents, there were 218 firms operating or proposing—on paper—to operate. Contracts were made to deliver enormous quantities of phosphate, the existence of which was still a mere matter of conjecture. The boom has been punctured, the wind is escaping, and the industry is approaching a legitimate basis; but there is considerable inflation still.

The installation of a plant, as well as the operation of a mine, is the work of an engineer. But the managers and superintendents are generally selected for other reasons than their fitness for solving this feature of the enterprise. Never was a finer opportunity offered for riding hobbies. In the absence of established precedents, never was there a greater variety of remarkable and mistaken plans pursued. Among the new and remarkably variable conditions which exist, all have committed errors more or less serious. Capable men are profiting by their errors; incapable men are still pursuing butterflies.

The cheapness of production has been very greatly exaggerated, an error which the evidence of a hundred or more idle mines in the state seems unable to fully remove. High grade phosphate now brings at the mine (that is, net to the miner) from $5.00 to $5.50 per ton; and despite all said to the contrary, this allows but a narrow margin of profit.

There are exceptional cases where the margin has been broader, but these are exceptional. These exceptional cases, it seems, are often taken as average.

High grade phosphate is found only in the land deposits of boulder and slate rock, with the exception of the deposits in the Withlacoochee, which the Dunnellon Co. is working with two dredges. This deposit, however, is considered very limited.

The boulder rock—whose name describes its form—is found in masses weighing from a few pounds to several tons, in a matrix of sand, clay, phosphate, gravel or soft phosphate, sometimes with a liberal mixture of flint and sand rock. There is no uniformity, as to location, size or character of matrix. One boulder may be found, with no other within the radius of several feet, and in fact may exhaust the deposit. Again, they may be found at frequent intervals, and in large quantities. The matrix changes completely and suddenly and according to no law. The quantity of phosphate, and the character of matrix on an area of 10 sq. ft. is not even an approximate indication of what would be found on any of the adjoining squares of the same area.

The plate rock phosphate deposits are unlike the boulder deposits except in uncertainty and variableness. They lie on the Vicksburg limestone, which evidently at greater or less depth forms the foundation of Florida. They are in the form of a gravel, the phosphate being generally in flat plates, in a matrix of sand, clay and sometimes soft phosphate.

The limestone juts up in crags and peaks, and the phosphate gravel clings to it in layers varying from a few inches to several feet. In places there are deep basins in the limestone, in which large deposits of gravel are found.

It is impossible to estimate beforehand the quantity of rock on a given tract, or the cost of mining it; local conditions are too variable, and the information gathered from "boring" and "pitting" too uncertain. By careful boring and pitting a deposit may be classed "good, bad or indifferent," but to ascertain more, actual mining is necessary.

There are quite a variety of plans for mixing high grade land phosphate, from the negro and wheelbarrow to the elaborate trolley and derrick systems. Heavy, unwieldy machinery cannot be used to advantage, on account of the uncertainty of the deposits and the general necessity of frequent moving. Much money was lost on this class of machinery before the character of the deposits was better known. Light derricks and trolleys capable of easy moving have proved most satisfactory.

Boulder phosphate is not generally cleaned. Plate rock and other phosphate gravel requires washing. There are several kinds of washing machines in use, some of which do fairly satisfactory work; but none have yet been brought to a very high state of excellence. However, this part of the problem has arrived at a point nearer solution than perhaps any other.

The drying of the washed material seems to present more difficulties. Among the numerous types of dryers none seems altogether free from serious defects. Efficiency, simplicity, durability, seem hard to combine in the dryer. It is difficult to dry the phosphate without burning it, which puts in a bad shape the iron and alumina in it.

From the time the earth is turned in mining until the prepared material is put on the cars, all the operation of plants in the state, it is safe to say, is open to improvement. Inexperience and lack of standard methods seem prevalent everywhere. Cannot some of the capable men who have assailed the problem give their experiences, and effect from the combination some lessons of value to all? All who are now working the Florida phosphates need more perfect plant and processes. B.

THE VENTURI WATER METER.

The Venturi meter, in the words of Mr. Clemens Herschel, the inventor, "is an instrument to gage the quantity of water flowing in a pipe, by measurement of an abrupt, artificially produced depression in the hydraulic gradient." A brief description of this instrument appeared in Engineering News of Dec. 24, 1887, as a condensation of a paper by Mr. Clemens Herschel, since printed in Trans. Am. Soc. C. E. for December, 1887. In this paper Mr. Herschel described the instrument and gave an account of some experiments made by him to determine its accuracy. Since that time the meter, and more especially its recording apparatus, has been perfected, as described below.

At the recent meeting of the New England Water-Works Association, at Holyoke, Mass., Mr. R. A. Robertson, Jr., C. E., read a paper on the Venturi meter, bringing its record down to date. Mr. Robertson informs us that the Builder's Iron Foundry, Providence, R. I., of which he is treasurer, is prepared to make these meters of any size, and is now making a 30-in. meter for the Citizens' Water Co., Denver, Colo. The paper on this meter is of so much interest that we print it below with but slight condensation:

The problem of the commercial measurement of large quantities of flowing water has for a long time resisted all efforts made by hydraulic engineers toward its solution. Positive mechanical meters, reciprocal or rotary, hardly applicable to streams of diameters over 4 ins., failed utterly when diameters nearing 1 ft. or quantities nearing 1,000,000 gallons daily are reached.

Many methods have been devised to this end, but in every case the cost of construction and setting of the cumbrous apparatus employed, the expense of maintaining them and the care required in their use, the loss of head, and the general inaccuracy of the results obtained, have been such as to prohibit their use. Even the weir, recognized as the standard means of measuring water in large quantities for tests, can only be used under conditions in close imitation of those under which the apparatus has been standardized; this, too, at the expense of a considerable amount of head, and with a heavy cost in setting and maintaining.

That an instrument, to be available for this purpose, must be both cheaply constructed and maintained at small cost, is necessitated by the low value of the water gaged; it must also operate without serious loss of head. Its action must be continuous, and its indications automatic.

For such a means of measuring water in large quantities, there has grown a demand not to be stifled by repeated failures. When, at the meeting of the American Society of Civil Engineers, December, 1887, Mr. Clemens Herschel presented his paper on The Venturi water meter, he made public a solution of this problem, and described careful, severe and satisfactory tests carried on here in Holyoke, it is not strange that his confreres should award him the Howland prize for his invention.

Mr. Herschel has very aptly given to his invention the name of "Venturi Meter;" for it was the Italian philosopher Venturi, who, about one hundred years ago, first called attention to the peculiar movement of fluids flowing through converging and diverging tubes, and made known the results of a series of experiments relating to this subject.

Since Venturi's time a host of scientific men have studied the laws covering the flow of fluids in converging tubes, and varied are the applications made of their discoveries; but it is Mr. Herschel's honor that of all these scientific men he alone saw the practical application of these laws.

The meter itself is of extremely simple construction. It consists of a contraction to be introduced into a pipe-line, to produce an abrupt depression in the hydraulic gradient, from the measurement of which the quantity of water flowing can be accurately determined.

In Mr. Herschel's experiments gages or piezometers were connected with the meter, one at the throat or smaller section, and one at some convenient point at the up-stream side of the contraction. The difference in pressure indicated by these gages was the head on the meter. Substituting this head in the simple formula $V=\sqrt{2gH}$, where (V) represents the velocity through Venturi, and (g) the velocity attained by the falling body in one second, a coefficient approximating to one was obtained. The coefficient showed a remarkable constancy, whether applied to a rough meter and 9-in. pipe, or a smooth meter and 1-in. pipe, with velocities through the pipe ranging from 1 ft. to 6 ft. per second.

Measurements with weirs are only to be made by practical repetitions of the Lowell experiments of Mr. Francis. Taking only weirs without end contractions and with depths on the weir ranging from 3-10 ft. to 2 ft., the coefficient of flow varies 7%.

In the case of the two meters previously mentioned, so different in size and structure, with areas in the ratio of 81 to 1 frictional surfaces widely differing, the combined range of coefficient did not equal this figure for velocities measuring from 5 to 50 ft. per second through the venturi. During the entire test of the larger meter, in which none of the defects existing in the other had been corrected, did the coefficient found from a single experiment depart from the mean by more than 0.5%. The precise conditions of every day practice were attained in the tests of the 4-ft. meter at the Macopin intake of the East Jersey Water Co. Here the water was run through the meter, set permanently in the pipe-line, in quantities varying from the rate of 2,500,000 to 50,000,000 gallons per day, thus providing quite a severe test.

Despite the radical changes of form and proportion, the performance of this meter not only confirmed the deductions arrived at from the other tests, but by the increased uniformity and closer approximation of the coefficient to one justified the changes made for the better guidance of the water, and of obtaining precise pressures.

Mr. Herschel also made a series of experiments on a 1-in. meter, the result of which, notwithstanding the imperfect gages used, correspond very nearly with the Holyoke experiments. Mr. Herschel's experiments receive a most interesting confirmation in those of Mr. James Brownlee, who gave the results of his experiments in a paper read some years ago before the Institution of Engineers and Ship Builders in Scotland. These results, though obtained from a tube whose throat was only 0.1982 ins. in diameter, coincide almost exactly with those obtained by Mr. Herschel for the 1-ft. meter. This confirmation of the theory is particularly valuable, in that it was obtained by men who never heard of each other, and who followed out different lines of investigation, on tubes varying widely in size and in details of construction.

Dependent as its operation is solely upon the principle of the relation between velocities and pressures, the scope of this form of meter would appear to be very great. Certain it is that the metering of any quantity of liquid up to 150,000,000 gallons per diem is now easily within the compass of a single instrument, with but the probable error of 0.5%. An instrument, too, that is of such simple construction as to cost but little more than its own length of pipe which it will displace, weighing less, and at no part exceeding the latter in diameter. Without moving parts its durability is insured, and its repairs will form no item of expense; sticks, dirt, fish, or any other foreign matter which would seriously derange the action of an ordinary meter, will pass the venturi without disturbance. As has been said, one might raft logs through a 36-in. meter without injury.

The 1, 4 and 9-ft. meters, above referred to, are of wood, built up inside a metal tube, and lined at the throat with brass. The use of wood, however, is not to be recommended, on account of the swelling and warping sure to take place, and of its lack of strength.

Fig. 1 represents the 36-in. meter, designed for the East Jersey Water Co., to measure the supply of the city of Newark, N. J. It is made entirely of cast iron and swept smoothly to the required shape. The throat is lined with brass, and the pressure at the head or up-stream end is taken from an air-chamber around the body of the tube above the beginning of the cone, and connected with the interior by cleanly drilled holes. The throat is surrounded by a similar chamber, and vent holes in it are drilled in the same plane, perpendicular to the axis, and with clean, sharp edges.

FIG. 1. 36-IN. VENTURI METER TO MEASURE WATER SUPPLY OF NEWARK, N. J.

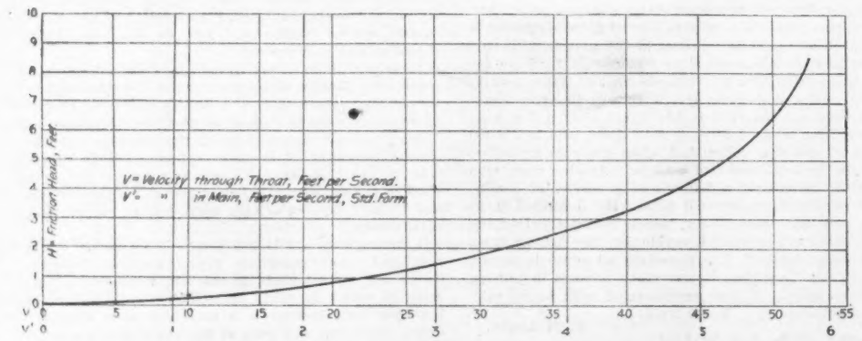


FIG. 2. DIAGRAM SHOWING LOSS OF HEAD DUE TO FRICTION IN VENTURI METER FOR VELOCITIES THROUGH THROAT RANGING FROM 0 TO 50 FT. PER SEC.

The rounding of the up-stream intersection of the cone with the cylinder of this meter, as compared with the Holyoke meters, and the greater smoothness of the cylinder and the superiority of the metal surface over the wood, will contribute materially toward reducing the friction and consequent loss of head, and will also produce a greater uniformity of flow, and increase the precision of the indications.

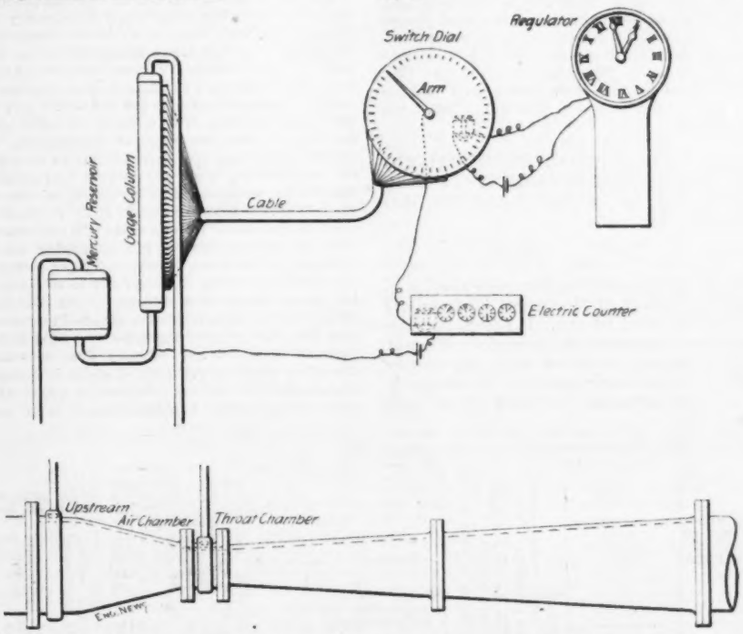


FIG. 3. VENTURI WATER METER AND RECORDING GAGE AND CONNECTIONS.

The length of the meter is about 10½ times the diameter of the trunk. One to nine has been taken as the ratio of the area of throat to that of the pipe, and where the loss of two or three feet of head is of no consequence, it will be best to use that ratio, as with high velocities through throat of meter, greater accuracy and uniformity is obtained, but the instrument can be varied in any or all of its proportions to suit specific requirements, and when it is not important that the meter should measure accurately a wide range of quantities it can be so proportioned that the maximum loss of head shall not exceed 1 ft.

With the maximum velocity which is allowed in pipe-lines by good practice, say 6 ft. per second, there will be a velocity of 54 ft. per second through the throat of a meter whose ratio is 1 to 9. The loss of head when passing this quantity will not exceed 10 ft. The loss of head falls rapidly as the flow is reduced. With a flow of 5 ft. per second through the pipe, and a corresponding velocity of 45 ft. through the throat of meter, the loss of head will not exceed 4½ ft.

In ordinary water-works service the velocity in pipe-lines seldom exceeds 4 ft. per second, corresponding to a loss of head due to the meter of less than 3 ft. For almost any case other than for water supplied to mills for power, this friction-head can be easily afforded. Fig. 2 is a diagram showing the loss of head due to friction in venturi meter for velocities through the throat ranging from 0 to 50 ft. per second.

It cannot be claimed for the meter that it will successfully operate for very low velocities. The fundamental principle of its action precludes this; but those velocities of which measurement is below the scope of this instrument, are equally outside the pale of practice. By the use of very sensitive gages, measurements of extreme accuracy can be made, and this meter be employed to advantage in tests in place of weirs; and, as it requires less care in setting and operating, its range of variation is much less. But the commercial success of the meter for use in mains is dependent upon the employment of some instrument which will indicate the amount of water passing at any time, and record the total quantity that has passed.

To devise a satisfactory indicating and recording instrument to do this, has been the very serious practical problem. Mr Herschel devised several, which, while most ingenious, yet presented some mechanical defects. Several instruments, more or less ingenious, have been successively developed by other engineers, and at length all mechanical defects seemed to be eliminated; but still, all the recording instruments of this class were radically defective, in that none possessed the power to indicate at a glance the quantity of water that had passed.

Mr. H. D. Pearsall, of London, England, suggested the use of an ordinary house meter, to be set on a by-pass pipe leading from the up-stream connection to throat of meter. The flow through it would be proportional to the flow through the venturi, and, if properly rated, its dial should indicate the volume passing through the meter.

Mr. Pearsall has patented the use of this arrangement. While it is a distinct improvement over all other instruments previously mentioned, it seemed, after careful investigation, liable to failure.

The long sought for instrument has at last been found in an invention of Mr. F. N. Connet. This instrument, for which a patent has been applied, is shown by Figs. 3, 4 and 5.

As shown by Fig. 3, in a loop of pipe connecting the throat and up-stream end of meter is inserted a gage-column of non-conducting material, and a closed reservoir containing mercury. The gage-column is of sufficient length to permit the mercury, as it is displaced from the reservoir and rises in it, to balance any difference of pressure that may at any time exist between the throat and up-stream end of the meter.

Through the shell of the gage-tube wires are inserted, each of which is connected with one or more buttons spaced about the periphery of a switch-dial. An arm is made to revolve over the face of the switch-dial, and is connected to the mercury in the gage-tube by wire, through a counter and battery.

The velocity of flow in the throat of meter is determined, as stated before, from the excess of pressure at the up-stream end over that at the throat. In this instrument, this head on the venturi is indicated by the difference between the level of the mercury in the reservoir and that in the tube. The conductors inserted through shell of tube are spaced in such a manner that the number in contact with the mercury is always proportionate to the velocity of flow through meter. The switch-arm revolves at a constant rate, and in one revolution touches every button on switch-dial. There will be as many circuits made and broken, and indicated by this counter, as there are contacts with the mercury in the column. The readings of the counter, then, are directly proportional to, and indications of, the rate of flow through the meter.

With the sectional area of the throat and times of revolution of the switch-arm known, the train of gearing in the counter is made such that a positive volume record is made of the flow. The counter adds up the flow for successive cycles for an indefinite period; its dial reads in feet or gallons. The switch-arm may be driven either by powerful clock-mechanism or by an electric regulator clock. These, with counter and batteries, may be placed at almost any distance from

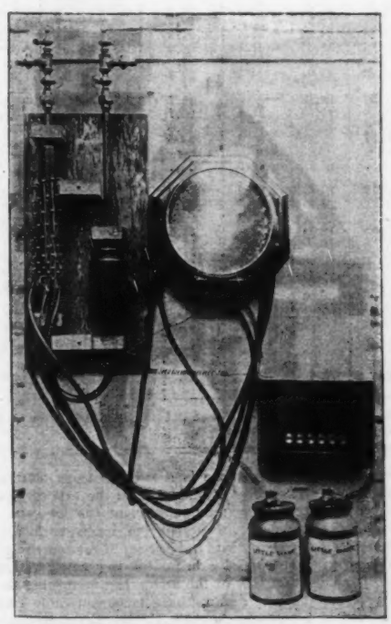


Fig 4. Case and Switch Dial Removed.

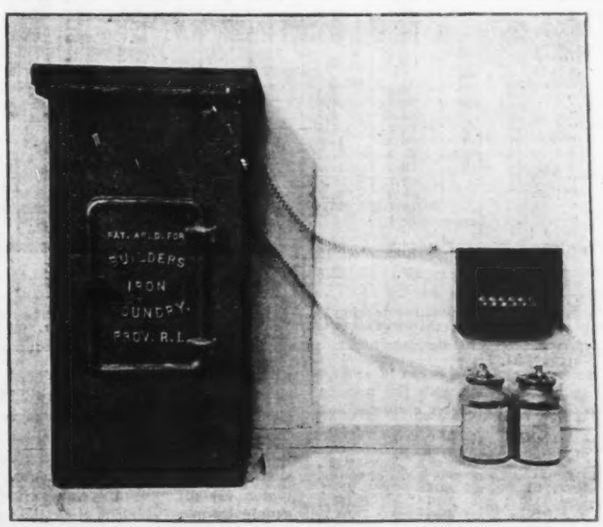


Fig. 5. Ready for Service.

RECORDING WATER GAGE FOR VENTURI METER.

the meter. The mercury column, for convenience, may be placed at a very considerable distance from the meter.

Fig. 4 is reproduced from a photograph of the instrument, with its covering case removed and with the switch-dial temporarily placed at one side, instead of in front of gage, in order to expose the mercury reservoir and gage-tube to view. Fig. 5 shows the apparatus as ordinarily set up, except that, as before stated, the recording dial may be placed at any distance from the other parts of the instrument.

This particular recording apparatus was made to accompany a 16-in. meter, furnished to the Montclair Water Co., which supplies the township of Montclair, N. J. The maximum velocity of flow through the throat of this meter will not exceed 25 ft. per second, roughly corresponding to 2,500,000 gallons in 24 hours. A variation of 0.02 ft. in head on the venturi was readily indicated, though such accuracy is not necessary in a recorder of this class, because the intervals between conductors inserted in the gage-column, which are made to correspond to increments of ¼ ft. in velocity through throat, above 4 ft. are greater than this. The minimum flow through the meter is about 5 ft., though the recording instrument is arranged to indicate flows as low as ¾ ft. per second.

It is, however, likely that the readings of velocities below 2¼ ft. per second would be somwehat in error. As the meter in question is never expected to measure such small quantities, the action of the recording instrument is interesting only as what it might do.

The following table indicates the difference in level of mercury in the reservoir and tube, when in contact with different conductors, together with the velocity of flow through the throat of the meter corresponding to such contacts:

No. contact.	Vel. in Venturi, ft. per sec.	Cu. ft. per sec.	Rise of mercury in tube, ins.	Head on Venturi, ft. of water.
1	¾	.116	.007	.0061
2	1½	.232	.028	.036
3	1¼	.348	.064	.082
4	3	.464	.114	.146
5	3½	.542	.115	.198
6	4	.620	.202	.259
7	4¼	.659	.228	.292
8	4½	.698	.256	.328
9	4¾	.737	.285	.365
26	9	1.396	1.024	1.31
44	13½	2.094	2.304	2.95
62	18	2.792	4.096	5.24
63	18¾	2.831	4.211	5.39
80	22½	3.49	6.400	8.19
81	22¾	3.53	6.543	8.37
89	24¾	3.84	7.744	9.91
90	25	3.88	7.882	10.108

This kind of recording apparatus possesses many interesting features that are not at first apparent. It automatically integrates any variation due to violent fluctuation of flow, and records only the mean flow. Should any refinement of accuracy be required, or further experiments make it seem desirable, the position of contacts in gage-column can be changed so as to correspond to minute variations found in coefficients for any particular meter, from zero to maximum flow.

The knowledge gained from the experimental meters that have been made is such as to warrant the declaration that the venturi meter will measure large quantities of fluids or gases far more accurately than they can be measured by any other means; and that its adoption is no longer attended with any trouble, uncertainty or risk.

SUMMARY OF RESULTS OF PRINCIPAL EXPERIMENTAL MEASUREMENTS OF PERFORMANCE OF REFRIGERATING MACHINES.

The paper with the above title, presented by Professors Denton and Jacobus, of the Stevens Institute of Technology, at the San Francisco meeting of the American Society of Mechanical Engineers, is one of great practical interest. It shows from actual tests the comparative efficiency of the different types of refrigerating machines which are now in use. The ammonia compression type of machine is shown by these experiments to stand on the whole compression machines were able to produce 9 lbs. to 20 lbs. or more of ice per lb. of coal used. This would indicate a cost for fuel per ton of ice of only 15 to 30 cts., more or less, and helps to show why artificial ice is able to compete in price with the product of a cold winter climate.

We reprint the substance of the paper as follows:

In order to measure accurately the cold-producing effect of refrigerating machines, it is necessary that the refrigerating fluid, when at its lowest temperature, be circulated in a closed coil submerged in an insulated bath of brine, which, by circulation in contact with some source of heat, is made to pass through a fixed range of temperature between the outlet and inlet of the brine reservoir. The quantity of brine circulated per unit of time, its range of temperature, and its specific heat, being then determinable by measurement, the refrigerating effect per unit of coal consumed to operate the apparatus may be stated as equivalent to the cold required to freeze water at 32° F. into ice at the same temperature. On this basis it is common to state that the performance of a refrigerating machine is equivalent to so many pounds of ice per pound of coal as a measure of fuel economy, and to so many tons of ice per 24 hours as a measure of its capacity. Any such statement of performance does not therefore represent that the refrigerating machine would make these amounts of actual ice, because: first, in making ice the water frozen is generally of about 70° temperature when submitted to the refrigerating effect of a machine; second, the ice is chilled from 12 to 20° below its freezing point; third, there is a miscellaneous dissipation of cold, not exactly definable, from the exposure of the brine tank and the manipulation of the ice cans—therefore, the weight of actual ice made with ammonia machines represents only about three-fourths of the cold produced in the brine by the refrigerating fluid* per indicated HP. of the steam engine driving the compressing pumps. Again, there is considerable fuel consumed in ice making, to operate the brine circulating pump, the condensing water and feed pumps, and to reboil, or purify, the condensed steam from which the ice is frozen. This fuel, together with that wasted at the head, although it is believed that the Pictet, or sulphur-dioxide machine, would show equally good results if tested under as favorable conditions. The ammonia absorption machine showed in the tests considerably lower efficiency than the compression machines. Theory indicates, however, that under certain pressures the absorption machine should be more efficient than the compression machine. Experiments to test this are about to be made.

While the above three types of machines do not differ greatly in efficiency, air compression machines, which are in somewhat extended use, fall very low in efficiency, being able by test to produce only 1-5 to 1-10 as much cooling effect per pound of coal burned as machines of the types more generally used.

The results of the test showed that the ammonia

* The cold produced in the brine may be only about three-fourths of that due to the latent heat of the weight of ammonia corresponding to the displacement of the compressors and the suction pressure density of the saturated vapor, as the superheating of the ammonia gas by the walls of the cylinder makes the weight of ammonia circulated about 25% less than this theoretical amount, assuming no loss by clearance, leakage or valve slip.

Actual and Theoretical Performance of Ice-Making Machines.

Class of Machine.	Authority.	Number of test.	Dimensions of compression cylinder, in in.	Absolute pressure, lbs. per sq. in.		Temperature corresponding to pressure in degrees Fahr.		Temperature of brine, in degrees Fahr.		Revs. per minute.	HP. of steam cylinder.	P. c. of indicated power of steam-cylinder lost in friction.	Ice-melting effect, in tons per 24 hours.	Ice melting effect in lbs. per lb. of coal (a).			Difference between theoretical ice melting effect, no superheating, no friction, and actual ice melting effect. Per cent. of the oretical with no friction.	Loss due to superheating during aspiration of gas in the compression cylinder and to radiation and superheating at brine tank. Per cent. of theoretical amount with friction	Mean effective pressure, lbs. per. sq. in.		
				Condenser.	Suction.	Condenser.	Suction.	Inlet.	Outlet.					Theoretical, no superheating during aspiration.		Actual.			Actual, including, resistance due to inlet and exit valves.	Theoretical, including resistance due to inlet and exit valves.	Difference of theoretical loss due to resistance at inlet and exit valves
														No friction.	With friction.						
1	2	3	4 & 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Ammonia Comp..	Schroter.	1		135.4	55.3	72.3	26.6	42.8	37.2	44.9	17.9	14.4	26.2	58.67	50.23	40.63	30.8	19.4	54.8	52.9	1.9
" " "	"	2		131.4	41.9	70.5	11.3	28.4	23.0	45.1	18.0	16.7	19.5	45.14	37.59	30.01	33.5	20.2	53.4	52.7	0.7
" " "	"	3		128.0	30.3	69.2	0.5	14.0	8.8	45.1	16.8	16.0	13.3	35 04	29 44	22.03	37.1	25.2	50.3	48.7	1.6
" " "	"	4	9.9 × 16.5	126.4	22.2	68.6	—11.8	—0.3	—5.6	44.8	15.5	19.5	9.0	28.29	22.76	16.14	42.9	29.1	44.7	43.5	1.2
" " "	"	5		199.5	41.9	95.5	11.4	28.3	23.0	45.0	24.1	10.5	16.5	29.79	26 68	19.07	36.0	28.5	77.0	72.9	4.1
" " "	"	6		135.8	60.0	72.4	30.2	43.7	37.2	45.2	17.9	10 7	29.8	64.74	57.85	46.29	28.5	19.9	56.8	52.1	4.7
" " "	"	7		131.4	45.1	70.6	17.8	28.8	23.0	45.1	18.0	12.1	21.6	48.40	42.56	33.23	31.3	21.9	53.4	53.1	3.3
" " "	"	8		125 6	23.7	68.2	— 9.4	—0.4	—5.8	44.7	15.6	18.0	9.9	29.83	24.46	17.55	41.1	28.3	46.1	43.2	2.9
" " "	"	9		116.9	41.0	64.2	13.1	28.4	23 0	45.0	16.4	13.5	20.0	50.53	43.70	33.77	33.1	22.9	50.6	46.5	4.1
" " "	"	10		130.0	60 3	70.0	30.7	42.8	37.3	31.7	12.0	11.8	19.5	69.40	59.09	45.01	35.2	23 8	52.0	49.3	2.7
Ammonia Comp..	Denton.	24	12 × 30	166.	42.7	84.2	15.0	36.8	28.9	58 1	85.0	22.7	73.9	35.91	27.36	24.16	32.7	11.7	65.9	67.8	—1.9
" " "	"	25		167.	22.9	81.6	—10.8	6.3	2.0	57.7	72 6	18.6	37.9	23.18	18.78	14.52	37.4	22.7	57.6	57.9	—0.3
" " "	"	26		162.	27.7	82.7	— 3.2	14.3	2.3	57.9	73.6	19.3	46.5	26.94	21.56	17.55	34.9	18.6	59.9	59.7	0.1
" " "	"	27		176.	42 2	87.7	14.5	36.4	28.5	58 9	88.6	19.7	74.4	33.54	26.94	23.31	30.5	13.5	70.5	71.6	—1.1
Ammonia Absorp	"	28	.....	152.3	40.4	79.1	12.6	20.7	15.7	....	....	....	42.2	38.5	.....	20.1	47.8	....	....	....	...
Pictet Fl'd Comp	"	11		56.7	20.9	77.3	23.5	43.0	37.5	57.0	21.5	22.9	25.6	55.01	42.48	33.07	39.9	22.2	24.1	21.7	2.4
" " "	"	12		55.6	14.9	76.2	14.4	28 5	23.0	56.8	20.6	22.9	17.9	41.05	31.71	24.11	41.3	24.0	23.1	20.3	2.8
" " "	"	13		54.6	9.7	75.2	— 2.5	14.1	8.8	57.1	18 5	24.0	11.6	30.22	23.36	17.47	42.2	25.2	20.4	18.4	2.0
" " "	"	14		60 4	6.7	80.6	—15 9	—0.3	—5 7	57.6	15.7	25.7	5.7	22.28	16.50	10.14	54.5	38.5	16.8	15.9	0.9
" " "	"	15	11.3 × 21.4	90.9	14.9	104.4	14 4	28.3	23.0	59.3	27.2	16.9	15.7	25.16	20.88	16.05	36.2	23.1	31.5	28.4	3.1
" " "	"	16		61.0	22.3	81.2	31.5	43.5	37.5	57.3	21.6	14 0	28.1	54.32	46.67	36 19	33.4	22.5	26.8	23.6	3.2
" " "	"	17		59 3	15.6	79 6	18.2	28.4	23.0	57.5	20.5	12 8	19.3	40.13	35.01	26.24	34.6	23.0	24.6	21 7	2.9
" " "	"	18		58.7	6.7	79.1	—15.9	—0.4	—5.6	57.8	15.9	21.1	6.8	22.72	17.90	11.93	47.5	33.4	18.0	16.6	1.4
" " "	"	19		54.3	22.2	74.9	31.3	42.8	37.5	35.3	12.4	22.3	17.0	62.83	49 17	38.04	39.5	22.6	22.6	20.9	1.7
" " "	"	20		88.7	15.6	102.9	16.2	28.3	23.1	42.9	19.9	14.7	11.9	26.78	22.86	16.68	37.7	27.0	52.7	28.5	4.2
" " "	"	21		62.1	6.5	82.2	—16.9	—0.1	—5.3	34.8	9.9	24.3	3.5	21.51	16.30	9.86	54.2	39.5	17.7	16.8	0.9
Bell Coleman Air.	Renwick.	22	28 × 23.8	58.8	14.7	64.8(b	—52.6(b	....	....	63.2	83.2	21.9	10.5	12.09	7.94	3.42	71.7	56.9	23.6	24.5(c)	2.3
Closed Cycle Air..	Jacobus.	23	10 × 18	175.	53.7	81.3(b	—40.2(b	....	....	93.4	38.1	32.1	4.9	14.8	8.1	3.0	80.	63.	89.2	75.3(c)	13.9

(a) The compression machine is assumed to develop 1 I. HP. for 3 lbs. of coal burned. The absorption machine is assumed to have an evaporation of 11.1 lbs. of water from and at 212° per lb. of combustible. (b) Temperature of air at entrance and exit of expansion cylinder. (c) Mean effective pressure for adiabatic compression.

in leakage and drip water, amounts to about one-half that required to drive the main steam engine. Hence, the pounds of actual ice manufactured from distilled water are just about half the equivalent of the refrigerating effect produced in the brine per indicated HP. of the steam cylinders. When ice is made directly from natural water by means of the "plate system," some of the fuel, used with distilled water, is saved by avoiding the reboiling operation.

It is therefore agreed that the term "ice-melting effect" means the cold produced in an insulated bath of brine, on the assumption that each 142.2 B. T. U. represents one pound of ice, this being the latent heat of fusion of ice, or the heat required to melt a pound of ice at 32° to water at the same temperature.

Of the refrigerating fluids which have been, or which still are, used in practice, there are no records regarding air and ether which enable us to state the "ice-melting effect." Ether machines, used in India, are said to have produced about 6 lbs. of actual ice per lb. of fuel consumed in driving the steam engine used as a motor, which would roughly prove that they realize as great a proportion of their theoretical efficiency as will be shown below to be obtainable from ammonia and sulphur-dioxide. The ether machine is, however, obsolete, because the density of the vapor of ether at the necessary working pressures requires that the compressing cylinder shall be about 6 times more cumbersome than for sulphur-dioxide, and 17 times larger than for ammonia. Air machines require about 1.2 times greater capacity of compressing cylinder, and are, as a whole, more cumbersome than ether machines, but they remain in use on shipboard, because the use of air incurs no such risk of destruction of provisions preserved by the cold as exists by danger from leakage when such chemicals as ammonia or sulphur-dioxide are used. There are also no records of the measurement of the performance of air machines by the use of a bath of brine, as described above, which enable the ice-melting effect to be stated, the air, at its lowest temperature, being either discharged free into the chambers to be cooled, as in the Bell-Coleman system, for example, or circulated through closed pipes lodged within such chambers, as in the Allen dense air machine. All measurements of performance of air machines have therefore been based upon the measurement of the range of temperature of the air between its entrance to the compressing cylinder and to the chamber to be cooled, combined with the weight of air circulated, the latter being computed from the displacement of the compression, or the expansive cylinder, by the aid of indicator cards.

Tests of Air Machines.—A fair sample of the above method of determination of performance of air machines is published by Prof. Schroter of Munich, for a Bell-Coleman machine, compressing air to about four atmospheres, and the result shows a refrigerating effect equivalent to 3.4 lbs. of "ice-melting effect" per pound of coal required to drive the steam engine, assuming 3 lbs. of coal per hour per HP. as the economy of the engine. This result is 43.1% of the theoretical result, computed upon thermodynamic principles, including an allowance for friction of mechanism of about 22% of the power of the steam cylinder, which was the actual friction as deduced from the indicator cards given by Prof. Schroter. A similar measurement of performance of a closed cycle air machine, compressing the air from 39 lbs. to 160 lbs. above the atmosphere, gives 3.0 lbs. of ice-melting effect, or 37% of the theoretical results. Such a machine, by handling the air at higher density than that corresponding to atmospheric pressure, has a proportionately smaller compressing cylinder, and is therefore more compact. The details of both of these tests are given in lines 22 and 23 of the table. The principal cause of the large difference between the theoretical and actual efficiency of air machines is the fact that the temperature of the air leaving the expansion cylinder is very much higher than theory indicates for adiabatic expansion, even taking into account all possible influence of moisture. Thus, in the Bell-Coleman machine the theoretical temperature, due to the pressure to which the air was compressed, is —109° F., while the actual temperature was only—53°. This result is not due to any deficiency in the adiabatic law of temperature, but probably to a rapid absorption of heat in the air by its contact with the metallic parts of the machine. Another cause of loss of theoretical effect is in the fall of pressure through wire-drawing of the air in passing from the compressing to the expanding cylinder.

Ammonia Machines, Absorption Type.—Several tests of this type of machine have been published by Prof. Schroter, of Munich, as a preliminary report of the Munich Polytechnic Commission, but the data do not permit the "ice-melting effect" to be satisfactorily determined, as the machines were devoted to ice-making. Allowing for the difference in the "ice-melting" and ice-producing effects, the results obtained are, however, nearly the same as that given in the table for a Pontifex absorption machine, in which the data are approximately complete for scientific purposes. This test was reported in Trans. Am. Soc. M. E., Vol. X., p. 792. The ammonia was worked between 138 and 23 lbs. pressure above the atmosphere. The ice-melting effect per pound of coal was 20.1 lbs. on a basis of boiler economy equivalent to 3 lbs. of steam per I. HP. in a good non-condensing steam engine. This result realizes 52.2% of the theoretical effect due to pure anhydrous ammonia, with no losses by imperfect action in any part of the apparatus. Detailed results are given in table. The principal losses are:

1. The steam to drive the ammonia circulating pump, which exhausted into the atmosphere, and used 16.4% of the total steam at the rate of about 150 lbs. per hour per HP. of the pump.

2. The heat carried off from the weak liquor by the water from the absorber, which was equivalent to 19.7% of the steam consumption.

3. Five per cent. of the weight of ammonia circulated is, on theoretical grounds,* believed to have been entrained with the ammonia throughout the cycle of the machine, which would cause 16.7% loss of theoretically perfect effect.

It is probable that more liberal proportions of the interchanger, or improvements in eliminating entrained water, and the saving of circulating pump steam, possible by arranging this pump to exhaust into the generator, would enable the realization of about 65% of the theoretical effect, a figure which, as shown below, is attained by the compression type of machine under average conditions. Under certain conditions of ammonia pressures, theory indicates that the absorption machine is superior in economy to the compression machine, even when the latter has the advantage of being driven by a compound steam engine. Experiments are needed to test the truth of the conclusions, and such experiments are about to be made by the writers on a large Pontifex plant.

Ammonia Machines—Compression Type.—Very complete determinations of "ice-melting effect" of this type of machine are now available. Ten experiments have been published by Prof. Schroter, as Secretary of the Munich Commission, using the plant erected for them by the Linde Co. of Germany. Lines 1 to 10 of the table give the results, which we have reduced to English units. The "ice-melting effect" (column 17) varies from 46.29 to 16.14, according as the suction pressure varies from about 45 to 8 lbs. above the atmosphere, this pressure being the condition which mainly controls the economy of compression machines. These results are equivalent to realizing from 72 to 57% (col. 19) of the theoretically perfect performance (col. 16). The higher per cents. appear to occur with the higher suction pressures, indicating a greater loss from cylinder superheating (col. 20) as the range of temperature of the gas in the compressing cylinder is greater. These experiments were made with double action compressors. Lines 24 to 27 show the results of experiments with single acting compressors on one of the leading makes of American compression machines, reported in Trans. Am. Soc. M. E., Vol. XII., p. 326. The percentage of theoretical effect realized ranges from 60.5 to 62.6%. The friction losses (col. 14) are higher for the American machine. The latter's higher efficiency may be attributed, therefore, to more perfect displacement. No clearance figures are published by Professor Schroter, but a comparison of the clearance action in the two types of machines, by means of the indicator cards, proves that the more perfect displacement is not caused by excessive clearance spaces, but by the greater loss by cylinder superheating (col. 20). This result is possibly ascribable to the smaller dimensions of the compression cylinders of the German machine, which afford the greater surface in proportion to the volume of gas compressed per stroke. The largest "ice-melting effect" in the American machine is 24.16 lbs. This corresponds to the highest suction pressures used in American practice for such refrigeration as is required in beer storage cellars. The conditions most nearly corresponding to American brewery practice in the German tests, are those in line 5, which give an "ice melting effect" of 19.07 lbs. Line 2, with a condensing pressure more favorable to economy of coal, but less favorable for economy of water, gives 30.01 lbs., but the per cent. of perfect action realized is about 1% less than for the American machine, notwithstanding that the latter's loss by friction is 6% greater.

For the manufacture of artificial ice, the conditions of practice are those of lines 3 and 4, and lines 25 and 26. In the former the condensing pressure used requires more expense for cooling water than is common in American practice. The "ice-melting effect" is therefore greater in the German machine, being 22.03 and 16.14 lbs. against 17.55 and 14.52 for the American apparatus. The percentage of theoretical effect realized again average greatest in the single-acting machine, however, notwithstanding that the friction is less in the German apparatus.

The superheating of the ammonia gas by the warm cylinder walls during its entrance into the compressor, thereby rarefying it, so that to compress a pound of ammonia a greater number of revolutions must be made by the compressing pumps than corresponds to the density of the ammonia gas as it issues from the brine tank, causes the principal loss of the theoretical effect given in col. 16 of the table.

In this theoretical estimate of the refrigerating effect, it is assumed that this density measures the displacement of compressor necessary to circulate a pound of the gas, but experimental measurement of the weight of ammonia circulated having been made in connection with the tests of lines 24 to 27, by metering the liquid ammonia, it was found that from 15 to 30% less ammonia is circulated than is accounted for by multiplying the compressor displacement by the density corresponding to the pressure and temperature of the ammonia gas at its entrance to the compressor.

Hence, as the pressure does not vary, the density must decrease by the rarefaction of the gas. Estimate shows that the heat to rarefy the gas, so as to account for the above discrepancy, could be lodged in the cylinder walls, and cause the same action that is represented by cylinder condensation in steam engines. The mean effective pressure is the same (see columns 21 to 23), for any range of pressure in the compression cylinder, whatever the density. Hence, the increase of power to operate the machine is directly proportional to the increase of volume due to the cylinder superheating.

Besides the cylinder superheating the discrepancies between the theoretical and experimental results in ammonia compression machines are as follows:

1. The liquid ammonia may be cooled by the condensing water below the boiling point corresponding to condensing pressure. This increases the useful effect, because there will be a less per cent. of each pound of ammonia vaporized in the brine tank, to chill the substance from the temperature at which it arrives at the expansion cock to the boiling point corresponding to such pressures. Such gain averages about 4% in the case of tests 24 to 27.

2. The ammonia gas may be superheated before leaving the brine tank above the boiling point due to suction pressure. This makes a temporary gain in the refrigerating effect obtained from a pound of the substance, amounting to about 2% in tests 24 to 27; but this gain is offset by the loss of effect due to the extra compression power, required by the increase of volume caused by the superheating.

3. The ammonia gas is superheated by absorbing heat from the atmosphere, in passing from the brine tank to the compressing cylinder. This in tests 24 to 27 causes a loss by increase of compression power of about 2%.

4. There are also small losses by radiation from the brine tank, which are probably not more than 1%.

On the whole, therefore, the loss of effect in ammonia compression machines is practically entirely due to the cylinder superheating, which reduces the ice-melting effect from 14 to 23% of the theoretical amount with friction considered, being roughly in proportion to the range of temperature in the compression cylinder.

Tests in which the balance of heat is within 3% afford values for the latent heat agreeing with the best physical values, to within from 1 to 4%.

Sulphur-Dioxide or Pictet Machines.—No records are available for determination of the "ice-melting effect" of machines using pure sulphur-dioxide. This fluid is in use in American machines, but in Europe it has given way to the "Pictet fluid," a mixture of about 97% of sulphur-dioxide and 3% of carbonic acid. The presence of the carbonic acid affords a temperature about 14° F. lower than is obtained with pure sulphur-dioxide at atmospheric pressure. The latent heat of this mixture has never been determined, but is assumed to be equal to that of pure sulphur-dioxide. The Munich Commission have published tests of a "Pictet fluid" machine, erected, for testing, in their laboratory. These tests are given in English units, in lines 11 to 21.

For brewery refrigerating conditions, line 17, we have, 26.24 lbs. "ice-melting effect," and for ice-making conditions, line 13, in which the "ice-melting effect" is 17.47 lbs. These figures are practically as economical as those for ammonia, the per cent. of theoretical effect realized ranging from 65.4 to 57.8%. At extremely low temperatures,—15°F., lines 14 and 18, the per cent. realized is as low as 42.5%. This is less than any ammonia efficiency, but so low a temperature was not tried with this substance. The Pictet machine was at a disadvantage in the German tests. In these tests the range of temperature of the circulating water was made the same in the two machines, and in tests of the sulphur-dioxide machine less circulating water was used than in parallel tests of the ammonia machine, so that the condenser pressure was higher in the sulphur-dioxide than it would have been had the machines been furnished with the same amount of condensing water.

* For argument on which this assumption is based, see Stevens' "Indicator," Jan., 1892.

On the whole the tests do not indicate any serious inferiority of efficiency in the Pictet system, and, theoretically, there should be no practical difference between the fluids.

It will be observed that sulphur-dioxide is susceptible to the same loss of cylinder superheating as is ammonia. A similar loss occurs in compressing air, which for pressures of several hundred pounds appear to be considerable, as in the case in volatile vapors; but for pressures of 100 lbs., the experiments of Messrs. Gause and Post at Hoboken show that the cylinder superheating, with jacket cooling, reduces the displacement only about 8%.

Carbonic Acid Machines.—No definite data exist regarding the performance of these machines. There seems to be no reasonable grounds for their use, as the pressures involved reach 800 lbs. per sq. in., and their efficiency is considerably less than ammonia machines. The compression cylinder is four times less in volume than is necessary for ammonia, but the high pressures required more than offset this advantage.

THE COMING DEVELOPMENT OF ELECTRIC RAILWAYS.*

Electric street railways are no longer experimental nor is their success problematical. Their history for five years is that of an almost unequaled development. Almost within a decade has occurred the first working of a practical electrical railway. In a third of that period there have been put in operation or under contract more than 450 roads, equipped with nearly 6,000 cars and over 1,000 motors, and with over 3,000 miles of track. There is made a daily mileage of not less than 700,000 miles, and over 1,000,000,000 passengers are carried annually. At least $750,000,000 have been invested in this industry alone; 30,000 horses in a single year have been relieved from the slavery of street car propulsion; stables are disappearing, and streets becoming cleaner; luxurious cars are running on smooth, well-built and rigid roadbeds. Dividends have been increased, expenses reduced, investments enlarged, the unproductive has become productive, the impossible, possible. Land values have been increased, habitable limits extended, homes created and time saved.

We no longer hear seriously of the dangers of the trolley wire, the failure of service. The time has come when legitimate investment is amply warranted. Electric street railway construction has become a matter of engineering, not experiment. Not only have the smaller towns adopted what is the only available means of current supply, but the larger cities are following their example. St. Louis and Baltimore, Minneapolis and St. Paul, Buffalo and Rochester, Boston and Brooklyn have fallen into line, and latterly even Philadelphia seeks an improved street service, and in New York public interest is being aroused.

In the latter city, it is of course, impossible to tell how successful will be the attempt to introduce electric propulsion. There is a strong and in many respects a legitimate objection to overhead wires. Many unsightly poles and badly strung wires have disappeared, and their place has been taken by an underground service.

The general feeling of opposition to poles and wires ought not, however, to act as a barrier to such reasonable and proper introduction of an overhead system of supply as the conditions now existing in that city very properly warrant.

In broad streets, where the tracks occupy only a small portion of the street and are near together, a line of poles of ornate design, with arms projecting on either side, can follow the center of the street, the same poles being used for lighting. Such a street, it seems to me, is Eighth Ave. Then, too, where there is a middle division or park, such as exists in many boulevards, and which is now used for telegraph poles, there is opportunity for an electric construction which would be entirely unobjectionable. On streets occupied with elevated structures, those structures themselves would be used for a practically rigid overhead system. Among the numerous places in New York where an overhead system could be put in perfect operation are Central Park West (Eighth Ave.), the boulevard from Fifty-ninth St. up, a part of the First and Second Ave. lines, the Third, Sixth and Ninth Ave. lines, and all suburban extensions from the annexed district.

I am not sufficiently familiar with the streets of Chicago, which is the last remaining city which must consider electric street railways, to suggest a plant.

In these large cities, however, one condition should be insisted upon, and if this condition is met in the proper spirit, then much of the objection which has been raised against an overhead system must necessarily disappear. The construction must be of the very best. The only overhead line allowed should be a contact wire with sufficient strength; the main conductors and the feeders should be put underground in proper conduits. There would then be overhead only a wire necessary for the smallest duty and of the requisite strength. In many streets of course the cable will hold its own until an electric conduit or surface contact system shall be proven satisfactory.

Impressed by the great development of this industry and brought face to face with the changes it has wrought, the query is continually made—will the electric motor replace the steam locomotive? It is similar to the older question—will the telephone replace the telegraph? Will the electric light annihilate the gas system—and in all soberness a like answer can be made: It will not, but it will, as the electric light and as the telephone have done, create a field of its own, and will replace a portion of the service now done by steam.

It seems to me that the growth of electric railways will proceed something in this order: First, the street systems in the various towns, then connecting lines between adjacent towns following the line of highways, then longer connecting lines, either on the track of existing steam lines, or growing bolder, on exclusive rights of way on the same order. Then will come suburban traffic on a larger scale, and freight transfer system, and finally the more ambitious projects of trunk line service under limiting conditions, such as I will specify.

But evidently this natural process of evolution does not offer scope enough for the more enthusiastic, and we are now and again treated to an ideal electric road to be built on plans boldly defying both geography and the abodes of civilization. An air line route according to rules of surveying allowed only in Russia and on the Desert of Sahara; abolition of the grade and street crossings; rigid and continuous rails; loaded cars of light weight, each operated by its own motor and making few or no stops; unlimited potentials and undiscovered resistance to insulation; new physiological and engineering laws; indestructible machinery; unheard of powers of braking and new methods of train operation and signaling; around all a clear atmosphere, above all a perpetually smiling heaven, and behind all an unlimited bank account and the unlimited confidence of the investor.

No one will question the capacity of a motor to do the necessary work required, or to make a speed superior to that of the steam locomotive, provided sufficient energy be delivered to its terminals, but we must deal with existing or probable methods of supply. It is true that the speed at which a train is propelled by steam has only increased about 50% in 60 years, for in 1832 the "Matthew Baldwin" often made a speed of a mile a minute, but we must not confound speed with power, for while the maximum speed has not been so materially increased, the endurance, the perfection of the mechanism and the economy of performance have made great strides, and the increased speed, which is by no means the maximum possible of a locomotive per se, has been attained at much higher powers, and the schedule time has been shortened principally by improvements in details and management which permit of higher speeds on more extended sections of road because of greater safety, lower traction coefficients and a greater degree of confidence possessed by the engineer.

All these things are necessary for high speed electric railways, and any general improvements that will be of benefit to the latter must necessarily be of service to the former. Now, any predictions which are made concerning the future of electric propulsion, either in ignorance or disregard of the possibilities of steam duty, and the limitations necessarily existing in all systems of transportation, deserve and will receive little consideration.

Hence, let us note a few of recent locomotive performances.

Mr. Sprague then proceeds to summarize the remarkable special and regular speed records made on the New York Central within the past year, the low coal consumption shown in Mr. Angus Sinclair's recent tests (3⅛ lbs. coal per HP. hour), and the recent runs on the New Jersey Central, all of which have been fully described in these columns. The remarkable records made with the Baldwin compounds on the latter road, however, will bear repetition, viz., one mile in 39¼ seconds (nearly 92 miles per hour) on Feb. 26; 10 miles in 452½ seconds, and 5 in 222 seconds on May 13, the fastest of these in 44 seconds, and the slowest in 47. A schedule rate of 86¼ miles in 89 minutes, including a number of necessary slackenings. The paper continues:

Experimental runs have been made with an electric locomotive at the rate of one mile in 30 seconds, that is, 120 miles an hour, and I confidently expect some day to go at that rate. But it will be under special conditions and not on the regular trunk lines of this country, and it is the height of folly to suggest that these steam trunk lines are to be abolished.

In making these very high speed runs there is not much attempt at maximum economy or coal consumption, the necessity being to generate steam as fast as required by the cylinder, but on taking an average of five trips, I find that there was evaporated 7.19 lbs. of water per pound of coal used and 0.41 lbs. of water evaporated per pound of coal consumed. The total weight of train varied from 213 to 241 tons.

The personal equations of engineer and fireman and special local conditions necessarily enter seriously into steam operations. I recently inspected a number of engine sheets. On one, which gave the duty of 25 engines, the average total cost per engine mile was 10.85 cts., of which 2.66 was for fuel. The total cost varied from 6.8 to 19.24 cts., and the fuel (wood) from 1.96 to 4.77 cts.

On another sheet giving the performance of 22 engines, the total cost per engine mile was 14.70 cents, of which the fuel cost 4.61. The total cost varied from 8.82 to 27.98 cts., and the fuel cost from 2.04 to 7.48.

In still another, that of the performance of 18 engines, the total cost per engine mile was 14.73 cts., of which the fuel (coal) cost 6.62 cts. The total cost varied from 10.04 to 22.52 cts., and the fuel cost from 3.82 to 13.84 cts.

In discussing the electric system there is often a confusion of statements with reference to economy. Despite the undoubted fact that the electric motor can probably be run at variable high speeds with less variation of economy than can the steam locomotive, we must not forget that in the latter we are considering the economy of the unit as a whole, not merely of the steam cylinders, but also of the boiler and the furnace.

In electric propulsion a similar comparison of economies must take into account the variable duty of the central station and the losses on the line as well as those in the motor, and where single units are used the variation in the economy of the whole system would be much greater than in a steam locomotive. There will be only a reasonable fixed efficiency of the central station and the line when the number of units is large enough to make the load on the central stations nearly constant.

Let us now consider another class of duty. Some time ago I made a very careful analysis of the work done on the elevated roads in New York City with a view of determining the coal consumption and the duty performed by the locomotives. At the time this investigation was made, now nearly seven years ago, there were in use on the Third Ave. division 63 trains at one time, running at very close intervals. The weight of the trains was from 80 to 90 tons; the speed was often as high as 20 to 25 miles an hour; stops were made every third of a mile; in short, the duty demanded of the engines was exceedingly severe.

The maximum indicated horse power of the locomotives was found to average about 163 HP., although on occasions these locomotives have been worked up to 185 HP. Work was divided approximately as follows:

Acceleration in starting 59%, lifting 24.3%, and traction 16.7%. The average horse power exerted was 70.3, considerably less than one-half of the maximum.

The work on the line was so distributed that there was an almost constant duty of about 4,500 HP. The locomotives were on duty 20 hours, but used steam only 6 hours, and including all losses when standing still and the amount of steam used in braking, there was a horse power developed for about 6.2 lbs. of coal. I believe that these figures are entirely reliable, and they show a remarkable performance when we consider the class of duty.

An analysis of the coal expenditures showed that, with an efficiency of 60% and without any of the energy of the train being returned to the line, the relative coal expenditures between steam and electricity would be about in a ratio of 2 to 1; but if the energy of the train was returned to the line to the extent which I believe is possible, then the relative expenditure of fuel would be in the proportion of 7 to 2. Since the coal charge on the four divisons was at that time about $550,000, it can easily be seen that, independent of any saving in the care of the structure and depreciation of engines, the fuel saving would be sufficient to pay good interest on the cost of electric equipment and a large interest on the cost of electric equipment minus the value of the present engines. I have no reason to doubt the soundness of the conclusions I then made.

You will have in Chicago, however, a somewhat more advanced condition of affairs. A compound type of locomotive has been adopted for the elevated road service, and I believe it will show an increased economy over that of the operation of the New York roads. Consequently, in discussing the question of economy, it is necessary to get full information concerning the duty which will be done here.

Mr. Sprague then points out the fact that experiments of Mr. Dudley and others show high speed train resistances to be lower than has been hereto-

* Inaugural address by Prest. Frank J. Sprague, read at the meeting of the American Institute of Electrical Engineers and the Chicago Electric Club, Chicago, June 6, 1892, somewhat abbreviated.

fore supposed, which is shown still more fully and conclusively in our issue of June 9. Considering also the gain to be had from stiffer rails and better track, Mr. Sprague justly concludes that the possibilities of the locomotive in the way of speed are by no means exhausted, and continues:

Almost all the locomotive work of the United States has been done up to the present with simple engines. Their weight and capacity has been increased, their steam pressure raised until the standard is now about 140 lbs. Within recent years, however, the compound locomotive has come into use, and there is a comparatively large number of them in daily service. The steam pressure has gone up to 180 lbs. as a standard, working sometimes as high as 200 lbs., but these are by no means the limits of steam pressure. On the Paris, Lyons & Mediterranean Ry. the standard for steam pressure for compound locomotives is 250 lbs. The compound locomotive has still its battle to fight, but I think it would be a rash man who will say that the days of still higher steam pressure are not to come, and that the triple expansion locomotive will never exist.

Speed, capacity and coal economy are, however, not the only questions to be considered in railroad operation, and in discussing the general subject, it will be found that the signaling and braking questions at high speeds are serious ones. Undoubtedly an electric train with distributed motors, making the weight of the train available for traction, could by using the motors as dynamos return the energy of the train to the line from the highest to mean speeds and then, after the speed fell lower, turning the current onto a local circuit, be more quickly and effectually slowed down and stopped than where shoe brakes are used, and both methods of course would be available.

(In this statement Mr. Sprague is true to the facts, though it has often been made and denied on many grounds, as explained on our editorial page. Judging from the wording of the sentence we infer that Mr. Sprague has himself made the claim from mistaken reasons.—Ed.)

(To be continued.)

BREAKAGE OF RAILS.

According to a note in London "Engineering," the traffic on the Danish State Railways (especially in Zealand) was considerably interfered with last winter owing to numerous rails breaking from the effects of frost. In fact, it became necessary to reduce the speed of the express trains and to alter the time tables in consequence. A commission of experts was appointed to investigate and report on the matter, which was most exhaustively dealt with. The commission says in its report that the breakages were partly owing to the quality of the rails and partly to the exceptionally unfavorable weather; in addition to which the weight of the rails is not sufficient for the traffic, the speed, and the weight of the locomotives, especially in regard to some of the Zealand railways. That the weight of the locomotives has something to do with the breakages appears from the fact that there have been comparatively few breakages of rails in Jutland, where the maximum weight per axle of the locomotives is 10 tons, while in Zealand it is 12½ tons, other conditions being equal. In future renewals and on new railways heavier rails will be adopted and a closer inspection exercised over the manufacture, but neither of these precautions could apply to the repairs which last winter's experience made necessary. To temporarily strengthen the track the number of ties has been increased from eight to nine or ten per rail length of 24 ft., and 84,000 splice bars have been renewed.

THE WEATHER IN NEW YORK CITY IN 1891.

The annual tables of the New York Meteorological Observatory, Central Park, New York city, for the year 1891 have just been published, and contain the following interesting matter, summaries and averages only being given:

The observatory is located at an elevation of 97 ft. above the sea, in lat. 40° 45′ 58″ and long. 70° 57′ 58″. The mean height of barometer during the year, reduced to freezing point, Fahrenheit, was 29.961 ins. The maximum height for the year was 30.722 ins. at 10 a. m. Nov. 19; minimum, 28.804 ins., at 4 a. m., Jan. 12; range, 1,918 ins.

The mean temperature for the year was 53.80° F. The maximum temperature was 98° F., at 5 p. m. Aug. 10; minimum, 9° F., at 7 a. m. March 2; range 89° F.

During the year out of a possible 4,284 hours of sunshine the sun shone 2,360 hours, or 55% as much as was possible. No clouds passed over the sun during 66 days of the year.

The total fall of rain and melted snow during the year was 38.82 ins., distributed over 118 days and making a total duration of rainfall and snowfall of 35 days and 55 minutes.

The table showing the fall of rain and snow by months is of sufficient interest to warrant its reproduction in full, as follows:

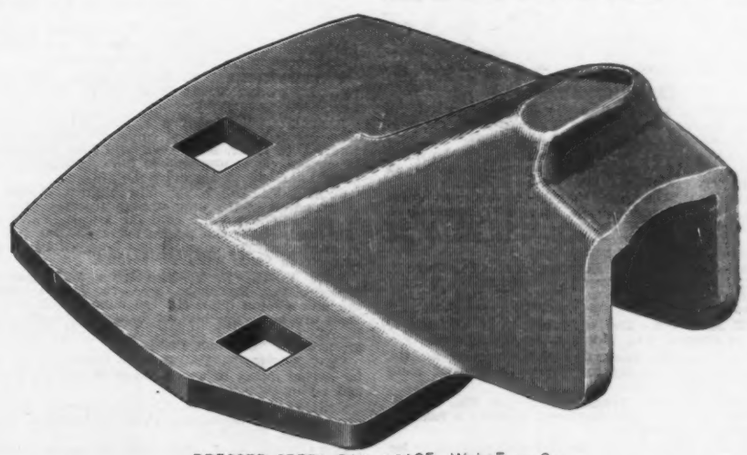
Duration and Depth of Rain and Snow at Central Park, New York, in 1891.

Months, 1891.	Number of days in which rain or snow fell.	Duration—Days.	Hrs.	M n.	Depth in inches.	Total depth in inches.	Depth of water pr'd'c'd in inches.
			Rain.				
January,	9	4	8	30	3.86	3.86	....
February,	12	3	13	45	2.47	6.33	....
March,	9	3	14	45	3.09	9.42	....
April,	6	1	8	45	2.38	11.80	....
May,	8	1	13	30	2.45	14.25	....
June,	8	1	5	30	1.48	15.73	....
July,	14	3	6	30	3.94	19.67	....
August,	14	1	19	45	4.51	24.18	....
September,	6	1	3	00	2.49	26.67	....
October,	8	2	19	15	2.60	29.27	....
November,	7	2	22	00	2.30	31.57	....
December,	8	2	15	10	2.82	34.39	....
Totals,	109	30	9	25	34.39	....	....
			Snow.				
January,	4	2	2	30	10.00	10.00	2.26
February,	3	1	20	00	5.25	15.25	1.65
March,	2	0	17	00	2.12	17.37	.52
Totals,	9	4	15	30	17.37	....	4.43

The total horizontal movement of the wind during the year was 61,196 miles, the greatest movement in any one month being 7,247 miles in March and the greatest movement in 24 hours being 477 miles one day in December, the exact date not being given. The maximum force of the wind during the year was 25 lbs. per sq. ft. at 7 p. m. Dec. 4. In September the maximum wind was only 4.5 lbs. per sq. ft., it reaching this point at 12:40 p. m. Sept. 14.

PRESSED STEEL RAIL BRACES.

The steady increase in the weight of rails and in the speed of trains, together with the growing cost of ties, is causing an equally steady increase in the use of rail-braces, as also of tie plates, by which the rail can be held secure and the life of the tie prolonged. The recent great expansion of the use of pressed steel and processes of making it has naturally suggested the use of that excellent material for rail braces, one form of which, manufactured by the Weir Frog Co., of Cincinnati, O., is here illustrated.



PRESSED STEEL RAIL BRACE; Weir Frog Co.

The Weir Frog Co. makes three designs of rail braces, differing only in style of base. The No. 1 has all the spike holes cut inwardly from edge. The No. 3 has the spike holes on the side protected by metal, while the hole in the shank is unprotected. The No. 5, shown in the accompanying cut, has all the spike holes protected. These braces are die formed, made of homogeneous steel plate ¼ or 5-16 in. thick as preferred, and so formed as to have parallel vertical sides. These vertical sides are bridged across under the head of the rail to strengthen them at the point where it engages the under and outer sides of the head of the rail. The vertical sides, and shape generally, are claimed to give a stronger and more rigid brace with the given thickness of material than any other brace yet designed. Being of box form, it fits over the spike in the tie, and then being secured with three spikes makes a very rigid support. They are made for any height or shape of rail, and in any quantity.

By bracing the rail under the head, as is done by these braces, the rail is prevented from canting, and the strain on the spike or inside flange of rail is removed, and then has equal bearing with the outside spike in keeping the rail in position. Many makers of cast iron braces think that if the flange and web of rail are protected this is sufficient. This is an error, however, as the liability of rail to cant is not prevented. The Weir braces being made of steel plate, are practicably indestructible, and a great saving is said to be effected by their use over that of cast braces, on account of the number of the latter broken in spiking, and to the number broken by the crushing strain due to defective casting and lightness of metal. It is said that the low price at which these braces are sold has caused some manufacturers of cast braces to make theirs very light to enable them to compete in price. Nearly two millions of these steel braces are in use on a large number of leading roads, including the Northern Pacific, Pennsylvania, Baltimore & Ohio, Louisville & Nashville, Boston & Maine, and Illinois Central.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

GOSHEN LATERAL.—Pres. F. E. C. Hawks informs us that owing to the bad weather slow progress is being made on the surveys for this 5-mile railway at Goshen, Ind. The line will run from the Lake Shore & Michigan Southern R. R. along the banks of the Goshen Hydraulic canal to a connection with the Cleveland, Cincinnati, Chicago & St. Louis R. R., and the road will probably be built by one of the above named companies. The object of the road is to reach the manufactories in the west side of the town and it will probably do a freight business only. There will be several bridges to construct.

LANCASTER, OXFORD & SOUTHERN.—About 120 men are now at work on this line in Cecil Co., Md., and the locating surveys north to Oxford, Md., are rapidly nearing completion. A. M. Neven who is in charge of construction, is reported as saying that additional work will be begun this fall.

BOSTON & MAINE.—This company will, it is stated, soon begin work on large freight terminals at Nashua, N. H., to cost about $178,000, exclusive of the land.

SANDUSKY & COLUMBUS SHORT LINE.—It is expected to begin tracklaying on this line from Bellevue, O., south in a few days.

PROVIDENCE & SPRINGFIELD.—It is stated that this company has marketed $750,000 of bonds, the proceeds to be used in building its line from Pascoag to East Thompson, R. I., 7 miles.

CANADIAN PACIFIC.—The company is building four extensions of branch lines in Manitoba this year, aggregating about 120 miles, but is not likely to have any important work going on in the Northwest before next year.

Projects and Surveys.

BALTIMORE & OHIO CONNECTION.—Chartered in Illinois to build a railway from a point near Beverly Hills, Ill., northwest to a junction with the Chicago Central Ry.

Southern.—Existing Roads.

KENTUCKY MIDLAND.—The survey for the line of railway from Frankfort to Alton, Ky., noted last week, is being made by the engineers of this company, according to the local papers.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—The location of the branch from Fordsville to a connection with the Newport News & Mississippi Valley R. R. has been completed, and it is likely that contracts will be awarded soon. It is expected to have the line in operation by Jan. 1, 1893.

ALTAMONT & MANCHESTER.—Work on this Kentucky railway, which was suspended on account of a strike, has resumed. C. E. Cooke, Pres., Altamont, Ky.

PADUCAH, TENNESSEE & ALABAMA.—The contract for building the 35-mile extension from Hollow Rock to Lexington, Tenn., has been awarded to McLaughlin Bros.

Projects and Surveys.

LOUISVILLE BELT.—It is stated that the project of building a belt railway at Louisville, Ky., has been revived with good prospects of success. A syndicate of capitalists, including Geo. L. Danforth, T. C. H. Vance, J. C. Fawcett and others, is said to be interested in the scheme.

MOBILE, NATCHEZ & COLUMBUS.—A railway company by this name has been chartered in Mississippi.

COAL RIVER.—This company has been chartered in West Virginia by T. L. Brown, R. T. Quay, Peter Fountain and others of Charleston, W. Va., to build a railway from St. Albans, W. Va., up Coal River to a connection with the Norfolk & Western R. R.

CUTHBERT & RICHLAND.—The surveys have been completed for a railway from Cuthbert to Richland, Ga., 23 miles.

CHERRY RUN & POTOMAC.—This company will soon begin the survey of its proposed railway from Harper's Ferry to Cherry Run, W. Va.

Northwest.—Existing Roads.

PEORIA TERMINAL.—Work will begin in 30 days on the extension of this railway. Ch. Engr., Jacob A. Harman, Peoria, Ill.

Southwest.—Existing Roads.

NATCHITOCHES.—Proposals were received on July 5 for grading a four mile extension of this road.

MISSOURI, KANSAS & TEXAS.—An agreement has been reached between the citizens and the Missouri, Kansas & Texas R. R. Co. for the building of the proposed extension of the latter's road to Houston from Boggy Tank, a distance of 80 miles. It is understood that the donation of right of way and a bonus of $25,000 are the inducements granted. The company will, it is stated, have a surveying corps in the field July 1 and complete the extension by Jan. 1.

CHICAGO, ROCK ISLAND & PACIFIC.—Surveys have been commenced for a line from Lincoln to Jansen, Neb., about 42 miles.

Projects and Surveys.

KANSAS CITY & NEW ORLEANS.—The "Manufacturers' Record" says: "The proposed route of the Kansas City & New Orleans Ry. lately noted, is from Clarkesville to Dalby Springs, 36 miles; thence south to the St. Louis & Southwestern R. R., at a point to be known as Desboro; thence southeast to Atlanta, Cass Co., some 40 miles, and from there to Collins Bluff, Ark., on Red River. A line is also to extend from Texarkana to Sulphur River. An Ohio firm is now figuring on the grading and bridging. W. A. Disborough is president of the company, and Hugh Stewart, Chief Engineer. Its office is at Dalby Springs, Tex."

ELECTRIC RAILWAYS.

CAMBRIDGE, MASS.—The Storage Battery Ry. Co. has been chartered to build a 3-mile electric railway. Edwin H. Abbot, A. L. Richards and others.

NEW HAVEN, CONN.—It is reported that the State St. Horse Ry. Co. will probably adopt electricity as motive power.

DIXON CITY, PA.—The Blakely & Dixon Traction Ry. Co., capital stock, $36,000, has been chartered to build an electric railway from Scranton, Pa., to the division line between the boroughs of Blakely and Archbald. Thos. Grear, Dixon City.

PITTSBURG, PA.—The directors of the Pittsburg & West End St. Ry. have voted to increase the bonded indebtedness from $75,000 to $500,000 in order to meet the expenses of changing their power to electricity.

STONE MT., GA.—The construction of an electric railway to Atlanta, Ga., 14 miles, is contemplated.

MACON, GA.—The Macon Consolidated Street Ry. Co. has applied for authority to convert its present mule lines into electric roads.

WARREN, O.—The Trumbull Electric Co., capital stock, $150,000, has been chartered to build a railway from Warren to Niles, O.

OSHKOSH, WIS.—Detroit parties are reported to be negotiating with the owners of the St. Car Co. for the purchase of its line. If the deal is consummated the road will be equipped with electricity.

OTTUMWA, IA.—The Ottumwa Electric St. Ry. Co. has sold its bonds and will build at once two miles of its line.

LINCOLN, NEB.—A company is being organized to build a 12-mile railway connecting this city with pleasure resorts in the vicinity. The road will be operated on the storage battery system.

HIGHWAYS.

COLORADO.—The Lima Creek Fall Road Co., capital stock, $20,000, has been chartered by Albert L. Eskew and J. S. Adalen and others to build a toll road in Hinsdale Co.

MARYLAND.—The Baltimore & Harford Turnpike Co., of Baltimore, will open bids July 10 for 1,500 perches of crushed stone for road purposes, subject to the approval of the company's engineer. Secy., W. H. Greenway.

BRIDGES, TUNNELS AND CANALS.

HARTFORD, CONN.—Councilmen Madden, Parker, Oakey and Newton have been appointed a committee to make arrangements for the erection of a new bridge over the Park River at Union Place.

HERKIMER, N. Y.—A special meeting was held July 5 to vote on question of raising $9,500 to erect a bridge across the West Canada Creek.

ELKTON, MD.—Proposals will be received until July 19 for the rebuilding of the Bohemian bridge, length of bridge 1,332 ft. between the face of the abutments, and contains 85 bents of piling and 90 ft. draw. The roadway on bridge proper will be 17 ft. 6 ins. in the clear. Roadway on the draw 14 ft. in the clear. Foundations for the new superstructure to be formed by cutting off the present piling at low water mark and placing a 12 × 12 yellow pine or oak cap at top of same. Bids are invited for both wood and iron superstructures. Bids addessed to County Comrs. at office in Elkton. C. H. Smith, Clerk.

HARLEYSVILLE, PA.—The Co. Comrs. have decided to build a bridge at Wendler's crossing. The commissioners will advertise shortly for proposals for the work.

FRANKFORT, IND.—Proposals will be received until July 26 for construction of a low truss wrought iron bridge, span 40 ft. Strain sheets must accompany all bids. Wm. B. Hill, Engr.

KENOSHA, WIS.—Sealed proposals are invited by the city of Kenosha for doing the work and furnishing the material necessary for raising and repairing Main St. bridge, in accordance with plans and specifications now on file with the city clerk. The work will include the raising of the center pier of the bridge 3 ft., the driving of piles, sawing same off below the water line, and building thereon a rock wall, with wings on either side, at the south approach; the building of a dock, driving piles, sheet piling and capping same at the north end of the bridge; the building of a revetment wall at the north end of the north approach to the bridge, and the doing of such other work in way of repairing the bridge and its approaches as may be necessary, in accord with the plans and specifications. F. W. Mathews, Cy. Clk.

WAUPACA, WIS.—An iron bridge is to be built across the Waupaca River at this place. Address, Mayor Shearer.

ADEL, IA.—The Board of Supervisors has decided to build a bridge at Perry, Ia. Length will be 172 ft. and cost, $8,000.

WATER-WORKS.

New England.

CAMBRIDGE, MASS.—A high service reservoir will probably be built soon.

HOLBROOK, MASS.—Bonds to the amount of $35,000 will be issued as an additional water loan. A survey of land for a basin in Ox Pasture has been ordered as a step toward condemnation proceedings.

ORANGE, MASS.—Bids will be received until July 14 for laying ten miles of cast iron pipe and setting accompanying gates and hydrants. F. L. Waters, Chn. Water Comrs.

WALTHAM, MASS.—The Council has ordered that steps be taken to introduce 3,000,000 gallons per day from the Charles River as an additional supply.

WOONSOCKET, R. I.—The Water Commissioners have been authorized to extend the mains into the town of North Smithfield for domestic use and fire protection.

WESTPORT, CONN.—It is reported that the Westport Water Co. has increased its capital stock from $50,000 to $100,000.

Middle.

ADDISON, N. Y.—Improvements are being made. Const. Engr., H. F. Labelle.

ALBANY, N. Y.—Bids will be received until July 12 for trenching for and laying 5,700 ft. of 6-in. pipe, setting hydrants, etc. Geo. I. Bailey, Supt.

FAYETTEVILLE, N. Y.—The people have voted 102 to 52 for works. P. H. Smith, R. W. Eaton and others are Water Commissioners.

FLORIDA, N. Y.—At a recent citizens' meeting it was decided to form a company and build works. Engr. J. B. Rider, New York, and John H. McCune are interested. It is proposed to take a supply from Glenmere Lake, about 1½ miles distant.

GLENS FALLS, N. Y.—The highest bidder for the construction of the new storage reservoir dam was J. W. Camp, Glens Falls, and the lowest, Flood & Sherrill, Sandy Hill; the prices being $23,200 and $12,771 respectively. The contract has been awarded to Hallman Bros., Little Falls, for $14,211.

NEW YORK, N. Y.—The Ryan & McDonald Construction Co., Baltimore, were the lowest bidders for the new Croton dam, the bid being $3,527,640. There were six bids, the highest being $5,566,879, from W. R. Allen & Co., St. Louis. A detailed list of bids is given under "Contract Prices."

NEW YORK, N. Y.—Bids are wanted until July 14 for laying mains in several streets and for furnishing and laying pipe in 103d St.

SPRING VALLEY, N. Y.—It is reported that a company has been organized; P. B. Lespinasse, Pres.; E. T. Turnure, Vice-Pres.

SYRACUSE, N. Y.—Bids will be received until July 11 for trenching and laying cast iron pipe with castings, gates and hydrants, as follows: 3,750 ft. of 6-in., 3,200 ft. of 20-in., 700 ft. of 12-in. pipe. Jas. B. Brooks, Secy. Water Bd.

WHITNEY'S POINT, N. Y.—The "Reporter" says works are needed.

ATLANTIC CITY, N. J.—The people voted, 892 to 323, June 30, to buy or build works to be owned by the city. A company built works in 1883 and a rival company in 1889.

WESTFIELD, N. J.—The Township Council proposes to contract for the building of works estimated to cost about $50,000. It is reported that the Connecticut Pipe Manufacturing Co. has offered to build works, including six miles of mains, for $35,000.

BROWNSVILLE AND BRIDGEPORT, PA.—Application has been made for the incorporation of the Brownsville & Bridgeport Water Co. by Chas. L. Snowden, N. N. Medora, and others. It is proposed to pump water from the Monongahela River to reservoirs, where filters will be located.

ERIE, PA.—It is reported that the intake pipe will be extended to deeper and purer water, but no definite plan has been officially decided upon.

MALVERN, PA.—An increased supply is proposed.

PHILADELPHIA, PA.—The Department of Public Works has been authorized to lay mains in many streets and to advertise for the erection of a 20,000,000-gallon filter plant at the Belmont station.

SHENANDOAH, PA.—Bids will be received by the borough until July 20 for the construction of works, as follows: Two compound duplex pumping engines, two reservoirs or steel or wrought iron tanks, about 15 miles of 12 to 4-in. mains. J. J. Franey, Chn. Sub-Com. on Water.

PENNSYLVANIA.—The Beltzhoover, Knoxville and St. Clair Water Cos. were incorporated June 29, each with a capital stock of $3,000, and with W. W. Murray, Knoxville, Treas. The Southwest Water Co. was incorporated June 30 to supply North Union, Fayette Co.; $5,000; Ephraim Love, Uniontown.

Southern.

MANNINGTON, W. VA.—It is reported that the Water Supply Co. wishes bids for furnishing 6-in. pipe.

WHEELING, W. VA.—The Council has authorized the expenditure of $110,000 for the removal of the pumping station up the river to secure a much-needed purer supply.

CHAPEL HILL, N. C.—Works are projected. Engr. J. C. Chase, Wilmington, is to report on the same.

HOGANSVILLE, GA.—It is reported that works are wanted.

MANSFIELD, LA.—Works are projected.

North Central.

GREENVILLE, O.—July 18 the people will vote for or against works.

ROCHESTER, IND.—The people have voted 441 to 78 for works.

SALEM, IND.—It is reported that surveys for an increased supply have been made by E. W. Blish, Seymour.

JACKSON, MICH.—Bids will be received until July 11, as follows: For an 8,000,000-gallon pumping engine to work against 60 lbs. domestic or 150 lbs. fie pressure; 2,000,000-gallon reservoir in excavation and embankment, bottom and slope paved; 200 tons of 24, 10 of 16, 8 of 14, 7 of 12-in. pipe, and 5 tons special castings; about 4,000 ft. of trenching and pipe laying. D. W. Smith, Pres. Bd. Pub. Wks.; J. K. Bogert, Secy and Supt.; J. D. Cook, Toledo, O., Consult. Engr.

CENTRALIA, ILL.—A vote on issuing $70,000 of bonds for works will probably be taken soon. If it does not carry, a franchise may be granted.

CICERO, ILL.—The Berwyn Water, Fuel & Light Co. has made a 24-years contract for supplying the southern part of the town, including Berwyn, Clyde, LaVergne and Morton Park. The town has the option of buying the works at the end of five years at a price fixed by arbitration. The hydrant rental will be $30 each, 50 to be in place this year, not more than 150 in 1893, 200 in 1894, 225 in 1895, and 250 in 1896. The plant will be located at Berwyn.

MOLINE, ILL.—There is talk of sinking two artesian wells, erecting a small pumping plant and a stand-pipe to improve the supply.

PONTIAC, ILL.—The Pontiac Water, Light & Power Co. has been incorporated; $60,000.

RICE LAKE, WIS.—A proposition has been made to put in works on a 15-years' franchise, with 40 hydrants at $1,600 per year.

Northwestern.

GRINNELL, IA.—Works have been voted.

OTTAWA, KAN.—The Ottawa Water-Works & Light Co. has been incorporated; capital stock, $100,000; Directors, S. M. Jarvis, R. R. Conklin, S. L. Conklin, Kansas City, Mo., and J. W. Pollock, Levi Shoner and J. L. Hawkins.

FREMONT, NEB.—It is reported that $29,000 has been appropriated for extensions and that the Board of Public Works will receive bids.

HARTINGTON, NEB.—Works are projected.

LINCOLN, NEB.—A 25 × 100-ft. steel stand-pipe is talked of.

NIOBRARA, NEB.—July 19 the people will vote on issuing $3,700 bonds toward works.

PONCA, NEB.—Bids for works complete, or for material or labor, will be received until July 30. F. M. Dorsey, Mayor; E. W. Huse, Cy. Clk.

SYRACUSE, NEB.—It is reported that the people have decided to build water and electric lighting plants.

WAKEFIELD, NEB.—Bonds for works have been voted, it is reported.

STURGIS, S. DAK.—It is reported that $75,000 will be expended for works.

KALISPELL, MONT.—A franchise for water and electric lighting plants has been granted to C. B. Davis, Chicago, J. A. Coram, Butte, and others. Cost, $85,000.

Southwestern.

CALDWELL, TEX.—An attempt will probably be made to get a company to build works, the town to take stock.

CALDWELL, TEX.—A committee has been appointed by the Aldermen to receive proposals for works.

KOSSE, TEX.—Works are projected.

SALIDA, COLO.—It is proposed to issue $20,000 of bonds for extensions and improvements.

Pacific.

KETTLE FALLS, WASH.—July 15 a vote will be taken on issuing $20,000 of bonds for works.

SUMNER AND PUYALLUP, WASH.—The Valley Light & Water Co. has been incorporated; $50,000.

BERKELEY, CAL.—A salt water system for street sprinkling and fire purposes has been proposed. Estimated cost, $125,000.

OGDEN, UTAH.—A franchise has been granted to Alonzo Hertig, Chicago, and others, for a second company.

ARTESIAN WELLS.

TOLEDO, O.—Bids for sinking a well will be received until July 11. Sylvester Lamb, Cy. Clk.

GOSPORT, IND.—The boring of a well is proposed.

LIMA, MONT.—The Lima Improvement Co. is making arrangements to sink a well.

IRRIGATION.

NEW COMPANIES.—Palouse Irrigating Ditch Co., Tacoma, Wash.; $500,000; Trustees, E. C. Smith, C. H. Beers and others. Walla Walla Irrigation Co., Walla Walla, Wash.; $150,000. Mojave Water & Fruit Co., Los Angeles, Cal.; $150,000.

SEWERS.

BOSTON, MASS.—Sealed proposals will be received until July 16 by the Board of Metropolitan Sewerage Commissioners, 93 Lincoln St., for building section 42 of the metropolitan sewerage system in Melrose and Stoneham, including 3,050 ft. 12-in. vitrified pipe and about 120 cu. yds. of brick and concrete masonry. Average depth, 11.5 ft. Hosea Kingman, Tilly Haynes, Harvey M. Collinson, Comrs.; H. A. Carson, Chf. Engr.

BOSTON, MASS.—The contract for section 7 of the main sewer has been awarded to C. A. Trumbull and W. H. Ryan, at $50,895. The prices are printed in another column. The City Engineer will receive bids until July 11 for 450,000 sewer brick and 800 cu. yds. gravel for section 6 of the Dorchester intercepting sewer.

NEWTON, MASS.—Bids will be received until July 12 for building section 6 of the system, including 16,600 ft. 6 to 15-in. pipe sewer, 210 cu. yds. brick masonry, 19,000 cu. yds. excavation. W. F. Harbach, Chn. Com. on Sewers; A. F .Noyes, Cy. Engr., West Newton.

SOUTHBRIDGE, MASS.—The Selectmen will receive bids until July 16 for 6,000 ft. of 6 to 14-in. sewer pipe; also for laying the same.

WALTHAM, MASS.—The sum of $25,000 has been appropriated by the Council toward the completion of the sewerage system.

PROVIDENCE, R. I.—The Council has appropriated an additional $75,000 for sewers.

NEW YORK, N. Y.—The Department of Public Works will receive bids until July 14 for sewers in three streets.

WATERLOO, N. Y.—It is reported that W. S. Parker, Pontiac, Mich., has been investigating the building of sewers here.

ELIZABETH, N. J.—Some 12 and 15-in. pipe sewers are to be built.

FREEHOLD, N. J.—A meeting will be held July 11 by the Board of Commissioners to decide the question of issuing bonds to procure money to pay the cost of the proposed sewer system.

PERTH AMBOY, N. J.—An ordinance has been passed authorizing the construction of a brick and pipe sewer and build pipe sewers in Elm, Oak, Prospect and Sanford Sts., and Watson Ave., to connect therewith.

RIDGEWOOD, N. J.—Sewers and water-works are talked of. Address, Chairman Township Committee.

BRADDOCK, PA.—The people have voted $100,000 of bonds for sewer and street improvements.

LOCK HAVEN, PA.—Messrs. Kistler, Funton, Peck and McLeod have been appointed a committee to devise the proposed sewers.

KNOXVILLE, TENN.—Proposals for constructing a system of sewers will be received by the Board of Public Works until July 15. M. Nicholson, Cy. Engr. There will be 2 miles of 24 × 36 ins. to 38 × 57 ins. brick, 47 miles of 8 to 24-in. pipe, 683 manholes, 336 flush tanks. See advertisement.

DURHAM, N. C.—A sewerage system is projected.

COLUMBUS, O.—Bids will be received until July 13 by County Auditor H. J. Caren, for building a sewer in East Broad St., as follows: 600 ft. of 12, 1,100 ft. of 15, 850 ft. of 18, 1,700 ft. of 20, 800 ft. of 24-in. pipe sewer and 3,300 cu. yds excavation and back filling. —The Board of Public Works of Columbus will receive bids until July 11 for a main trunk sewer 5,600 ft. long and from 4½ to 2½ ft. in diameter. Clk., F. M. Senter.

SPRINGFIELD, O.—Bids will be received until Aug. 1 for two 15-in. and one 18-in. sewer. S. J. Wilkerson, Cy. Clk.

WEST CLEVELAND, O.—The people have voted to issue $80,000 of bonds for a sewerage system.

ROCKFORD, ILL.—Bids will be received until July 11 for furnishing material for building 3,500 ft. of 24 to 10-in. sewers. F. G. Hogland, Cy Clk.

QUINCY, ILL.—Bids for about five miles of sewers have been rejected and new bids will be solicited.

AUSTIN, MINN.—Bids will be received until July 14 for the construction of sewers. Johan Wold, Cy. Recorder.

SIOUX FALLS, S. DAK.—Rudolph Hering, New York, has been engaged to design a system of sewerage and drainage for the city.

REDLANDS, CAL. All the sewer bids recently received were rejected and new bids requested.

STREETS.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids July 11, 14 and 18 for paving streets with cobblestone.

NEW YORK, N. Y.—Bids are asked until July 14 for seven contracts, grading, curbing, paving and sewers. L. J. Heintz, Comr. St. Imp., Wards 23 and 24.

FRANKLIN, N. J.—The Township Clerk will receive bids until July 11 for grading about 6,400 yds.

PHILADELPHIA, PA.—Several streets will be payed by contract at a cost of about $35,000.

PLYMOUTH, PA.—Bids are asked until July 11 for 3,150 sq. yds. brick paving and 2,700 lin. ft. stone curbing. J. C. Creveling, Secy.

REYNOLDSTON, PA.—This place has voted $25,000 for street improvements.

WASHINGTON, D. C.—Bids are wanted until July 16 for about 2,000,000 vitrified paving brick. J. W. Douglass, J. W. Ross and W. T. Rossell, Comrs.

LOUISVILLE, KY.—Ordinances for several street improvements have been passed. H. S. Tyler, Mayor.

CINCINNATI, O.—The Board of Administration will receive bids until July 23, 28, 29 and 30, for paving and street improvements.

DAYTON, O.—The City Comptroller has been authorized to ask for bids for grading and paving eight alleys.

MARIETTA, O.—Bids will be received until July 30 by the Council for brick paving and other improvements to three streets. L. Mueller, Cy. Clk.

TOLEDO, O.—Bids will be received until July 11 for grading and improving three streets and until July 25 for paving the central 26 ft. of one street with vitrified brick, cedar blocks or Trinidad asphalt on hydraulic cement concrete; also for grading, curbing, etc., the last street. Sylvester Lamb, Cy. Clk.

CHICAGO, ILL.—The Board of West Chicago Park Commissioners will receive bids until July 19 for 49,729 sq. yds. asphalt paving, 19,142 lin. ft. curb and gutter, 30,013 cu. yds. common filling, 165,882 sq. ft. composition sidewalk, 170 lamp posts and lamps, and 657 elm trees.

LANSING, MICH.—We are informed that about ¼ mile of streets will be paved with brick. Ernest Sellers, Cy. Engr.; W. C. Hinman, Cy. Clk.

LAKESIDE, MINN.—The City Recorder will receive bids until July 11 for grading, etc., Oxford St.

ify the town in voting for 40 electric lights and to vote for 15 additional lights.

ROCHESTER, N. Y.—At the next meeting of Common Council the question of placing electric wires underground on Main and State Sts. in accordance with the agreement between the city and the companies will be considered. The matter will be referred to the Electrical Committee and it will advertise for bids for the construction of conduits to be owned by the city and rented by the companies.

DOYLESTOWN, PA.—The Commissioners on Lamps and Lights will receive bids for the lighting of the town by electricity.

COLUMBIA, S. C.—The city talks of putting in an electric light plant. Address, W. B. Lowrance.

AKRON, O.—The City Clerk will advertise for bids for lighting the city for five years from July 25, at which time the present contract expires.

DETROIT, MICH.—The Park & Boulevard Commissioners will have plans prepared for an electric light system for Belle Isle Park.

QUINCY, ILL.—About $900 worth of new electric lights will be put in.

DEADWOOD, S. DAK.—Black Hills Electric Light Co. has issued $20,000 first mortgage bonds to provide for erecting a new power house and increasing and improving its system. Harris Franklin, Prest.

ADEL, IA.—The city will issue $10,000 bonds for erection of an electric light plant.

ROCKPORT, MO.—Has issued $12,000 for purpose of building water and electric light works.

NEW COMPANIES.—Quinnisch Electric Navigation & Power Co.; Hoboken, N. J.; $250,000; Arthur Schwarz, A. Benecke, Newark, N. J. New Gaynor Electric Co.; Louisville, Ky.; $100,000; J. W. Dawson, Jos. Myrick, Jr., Louisville, Ky. Electric Ry. & Car Co., Tiffin, O.; $50,000.

CONTRACT PRICES.

SEWERS.—Orange, N. J.—We have received from Mr. Horace Stetson, City Clerk, the list of bids for the Northern section of the sewerage system, opened June 27. The contract has not been awarded, but according to the engineer's calculation the lowest bid was that of the Delafield Construction Co. The bidders were as follows: 1, Empire Construction Co., New York; 2, W. J. Fordney, Lancaster, Pa.; 3, R. A. & B. E. Malone, Lancaster, Pa.; 4, Antonio Costa; 5, Delafield Construction Co., New York.

24-in. pipe sewer, per ft.	3.50	3.00	2.50	2.65	2.82
Each Y in 24-in. pipe.	3.75	3.50	5.68	3.25	3.80
20-in. pipe sewer, per ft.	2.40	3.00	3.57	3.25	3.26
Each Y in 20-in. pipe.	3.75	2.50	3.85	2.25	2.90
18-in. pipe sewer, per ft.	2.00	2.35	2.52	2.20	1.83
Each Y in 18-in. pipe.	2.50	1.80	2.97	1.70	2.16
12-in. pipe sewer, per ft.	1.75	1.50	2.36	1.70	1.20
Each Y in 12-in. pipe.	1.25	.70	1.70	.70	.80
10-in. pipe sewer, per ft.	1.75	1.46	2.10	1.53	1.26
Each Y in 10-in. pipe.	1.25	.55	1.30	.50	.56
8-in. pipe sewer, per ft.	.65	.80	1.58	.75	.70
Each Y in 8-in. pipe.	.70	.40	1.00	.50	.57
6-in. ho. conns., 6 to 8 ft., telford, per ft.	.50	.60	1.40	.50	.57
6-in. ho. conns., 8 to 10 ft., telford, per ft.	.55	.90	1.72	.60	.66
6-in. ho. conns., 8 to 10 ft., dirt, per ft.	.40	.50	1.34	.40	.42
6-in. ho. conns., 8 to 10 ft., dirt, per ft.	.45	.80	1.54	.50	.50
Manholes, per ft., less than 12	2.75	4.50	3.40	3.50	3.00
Manholes, per ft., more than 12	4.00	6.00	5.58	4.00	3.60
Flush tanks complete, each.	60.00	65.00	75.00	70.00	84.00
Lampholes, per ft.	2.00	1.00	.10	2.00	1.20
Concrete, per cu. yd.	6.00	4.50	5.00	5.00	7.20
Rock excav. per cu. yd.	3.50	1.00	3.00	5.00	4.00
Iron castings, per lb.	.03	.04	.03	.03	0.2½
Iron pipe, per gross ton.	60.00	26.00	33.00	30.00	40.00
Timber foundations, per 1,000 B. M.	50.00	25.00	28.00	35.00	40.00
Hemlock sheathing left in trench, per 1,000 B. M.	35.00	25.00	25.00	25.00	20.00
Spruce sheathing left in trench, per 1,000 B. M.	30.00	25.00	25.00	20.00	20.23
Excavations below grade, per cu. yd.	5.00	.80	1.00	2.00	.90
2½-in. tile laid, per lin. ft.	.20	.16	.14	.10	.15
3-in. tile laid, per lin. ft.	.20	.16	.15	.10	.16
4-in. tile laid, per lin. ft.	.75	.25	.16	.45	.17
6-in. tile laid, per lin. ft.	1.00	.30	.20	.50	.21

OMAHA, NEB.—The Board of Public Works will receive bids until July 15 for grading, and paving with sheet asphaltum, granite, brick, etc.

ELECTRICAL.

MALDEN, MASS.—The Malden Electric Co. will enlarge its plant by putting in two additional stationary engines.

BRISTOL, CONN.—A petition is being circulated asking the Selectmen to call another town meeting to rat-

DAM.—New York, N. Y.—In the following table are given the bids opened June 29 by the Aqueduct Commissioners for the construction of the new Croton dam at the Cornell site, the plans and description of which were given in our issue of June 2. The bidders were as follows: 1, Ryan & McDonald Construction Co., Baltimore, Md.; 2, H. H. Brown, New York; 3, M. S. Coleman, New York; 4, Winston, Crimmins, Washburne & Co., New York; 5 McQuade & Moore, New York; 6, Wm. Russell, Allen & Co., St. Louis, Mo. The last column gives the engineer's estimate:

Items.	Quantities.	(1.) $	$	(2.) $	$	(3.) $	$	(4.) $	$	(5.) $	$	(6.) $	$	Engr.'s Est. $	$
Soil, excavated and placed	2,000 cu. yds.	.30	600	.40	800	.30	600	.40	800	.30	600	.35	700	.35	700
Sodding	10,000 sq. yds.	.30	3,000	.30	3,000	.30	3,000	.20	2,000	.29	2,900	.30	3,000	.30	3,000
Earth excavation	550,000 cu. yds.	.37	203,500	.60	330,000	.65	357,500	1.10	605,000	1.00	550,000	1.34	737,000	.50	275,000
Earth excavation in vert. trenches	35,000 "	.75	26,250	1.00	35,000	.90	31,500	2.50	87,500	2.00	70,000	5.54	193,900	1.25	43,750
Refilling and embankment	900,000 "	.20	180,000	.30	270,000	.35	315,000	.25	225,000	.73	657,000	.33½	300,000	.30	270,000
Earth hauled	1'0,000 "	.006	960	.000	1,750	.0105	1,575	.0075	1,125	.0219	3,285	.01	1,500	.009	1,350
Rock excavation	300,000 "	1.25	375,000	2.00	600,000	2.00	600,000	1.75	525,000	1.38	414,000	2.32	696,000	1.50	450,000
Permanent timber work	200 M. ft. B. M.	30.00	6,000	40.00	= 8,000	35.00	7,000	39.00	7,800	35.00	7,000	35.00	7,000	40.00	8,000
Permanent timber work, 1	120 "	45.00	5,400	45.00	5,400	45.00	5,400	50.00	7,080	37.00	4,440	60.00	7,200	45.00	5,400
Cribwork	8 000 cu. yds.	3.50	28,000	2.50	20,000	3.00	24,000	1.50	12,000	2.50	20,000	4.00	32,000	2.50	20,000
Portland cement	1,000 bbls.	2.50	2,500	3.25	3,250	3.00	3,000	2.50	2,500	3.70	3 700	3.00	3,000	3.00	3,000
Concrete (American cement)	10,000 cu. yds.	4.00	40,000	4.65	46,500	4.28	42,800	4.90	49,000	5.57	55,700	4.80	48,000	4.50	45,000
Concrete (Portland cement)	3,000 "	5.28	15,840	6.138	18,414	6.5736	19,720	6.468	19,404	7.3524	22 057	6.336	19,008	5.94	17,820
Brick masonry	2,000 "	12.00	24,000	10.50	21,000	10.00	20,000	12.00	24,000	15.00	30,000	12.00	24,000	12.00	24,000
Rubble (Portland cement, 2 to 1)	470,000 "	3.75	1,762,500	4.00	1,880,000	4.00	1,880,000	4.90	2,303,000	4.32	2,030,400	4.80	2,256,000	5.00	2,350,000
Rubble (Portland cement, 2 to 1)	30,000 "	4.95	148,500	5.28	158,400	5.28	158,400	6.468	194,040	5.7024	171 072	6 336	190,080	6.60	198,000
Rubble (Portland cement, 3 to 1)	50,000 "	4.575	228,750	4.88	244,000	4.88	244,000	5.978	298,900	5.2704	263,520	5.856	292,800	6.10	305,000
Dry rubble	12,000 "	2.75	33,000	2.00	24,000	2.50	30,000	2.50	30,000	2.50	30,000	3.70	44,400	2.50	30,000
Rip rap	5,000 "	1.50	7,500	1.75	8,750	2.00	10,000	1.50	7,500	1.50	7 500	2.00	10,000	1.50	7,500
Broken stone	10,000 "	2.00	20,000	1.50	15,000	2.00	20,000	1.25	12,500	1.50	15,000	1.50	15,000	1.50	15,000
Block stone masonry	2,500 "	12.00	30,000	15.00	37,500	16.00	40,000	12.00	30,000	25.00	62,500	30.00	75,000	15.00	37,500
Granite dimension stone masonry	2,500 "	24.00	60,000	35.00	87,500	35.00	87,500	15.00	37,500	38.00	92,500	35.00	87,500	30.00	75,000
Facing stone masonry	24,000 "	12.50	300,000	14.00	336,000	15.00	360,000	11.00	264,000	30.00	720,000	20.00	480,000	15.00	360,000
Face work for rubble	15,000 sq. ft.	.40	6,000	.30	4,500	.40	6,000	.32	4,800	.70	10,500	.25	3,750	.30	4,500
Fine hammered face dressing, 2	22,000 "	.70	15,400	.65	14,300	.75	16,500	.60	13,200	.80	17,600	.75	16,500	.75	16,500
Rough pointed face dressing	12,000 "	.25	3,000	.40	4,800	.40	4,800	.30	3,600	.50	6,000	.35	4,200	.40	4,800
Highway fence	8,000 lin. ft.	.25	2,000	.50	4,000	.40	3,200	.15	1,200	.50	4,000	.30	2,400	.50	4,000
Totals			$3,527,640		$4,181,464		$4,298,495		$4,768,449		$5,290,774		$5,549,908		$4,574,820

1. Tongued and grooved. 2. Fine hammered (six cut) face dressing.

SEWER.—Boston, Mass.—The Metropolitan Sewerage Commission has received the following bids for Section 7 of the main sewer, which extends across and under Belle Isle Inlet, from Winthrop to East Boston, a distance of 800 ft. The work includes a 9-ft. sewer, a siphon, sand catcher, pipe chamber, masonry, piles and a cofferdam. The bidders were: (1) National Cons. Co., Boston; (2) Moulton & O'Mahoney, Boston; (3) Wm. H. Ward, Lowell; (4) Jones & Meehan, Jamaica Plain; (5) C. A. Trumbull and W. H. Ryan, Boston.

	Earth excav. and refill for sewer, siphon, etc.	Brick. 700 cu.yds.	Masonry.—Con-crete. 2,500 cu.yds.	Squ'd stone. 300 cu.yds.	Spruce lumber in place. 100 M. B.M.	Spruce piles driven. 11,000 lin. ft.	Total
	$	$	$	$	cts.	$	
1	61,000	7.05	3.75	3.00	40.00	0.20	82,410
2	37,120	7.00	5.00	3.00	35.00	0.25	61,670
3	35,000	6.00	3.25	3.50	35.00	0.30	55,175
4	33,500	5.00	2.75	5.00	35.00	0.25	51,685
5	34,675	5.00	2.50	3.50	30.00	0.22	50,895

PROPOSALS FOR SHEET ASPHALT AND ASPHALT BLOCK PAVEMENTS.

Office of the Commissioners, D. C.
Washington, D. C., July 5, 1892.

Sealed proposals will be received at this office until 12 o'clock m., on Friday, July 22, 1892, for laying sheet asphalt and asphalt block pavements.

Blank forms of proposals, specifications, and all necessary information can be obtained at this office.

J. W. DOUGLASS,
J. W. ROSS,
W. T. ROSSELL,
28-1t Commissioners, D. C.

SEALED PROPOSALS will be received by the Board of Public Works of the City of Indianapolis, Indiana, on or before 10 o'clock a. m., on Wednesday, August 10th, 1892, for the construction of a main sewer in and along Washington St., from Noble St. to Rural St., estimated to cost $70,000.00. The above sewer will consist of 7,600 ft. of Egg Shaped Brick Sewer, ranging in size from 1 ft. 6 in. × 2 ft. 3 in. to 4 ft. 2 in. × 6 ft. 3 in.; 3,385 lineal ft. of Circular Brick Sewer, ranging in size from 3 ft. to 5 ft. 6 in.; 40 catch-basins; 23 manholes; 7,000 lineal ft. of house connections.

Also for the construction of a main sewer in and along Merrill and New Jersey Sts., from Pogues Run to Wyoming St., estimated to cost $19,000.00. The above sewer will consist of 200 feet 3-ft. Brick Circular Sewer; 2,550 ft. of Egg Shaped Brick Sewer, ranging in size from 1 ft. 6 in. × 2 ft. 3 in. to 3 ft. 2 in. × 4 ft. 9 in.; 1,375 lineal ft. of 12, 15 and 18-in. Pipe Sewers; 1,035 lineal ft. of 6-in. house connections; 24 catch-basins; 11 manholes and one flush tank.

Plans, Sections, Blanks and Specifications for the above proposed main sewers may be seen at the office of the Board of Public Works, Indianapolis, Indiana. Each proposal must be accompanied by a bond or certified check in amount equal to one-tenth of the amount bid. No proposal may be withdrawn after the same has been submitted. A satisfactory contract and bond will be required of the successful bidder. The Board of Public Works reserves the right to reject any or all bids.

A. W. CONDUITT,
M. M. DEEPEES,
A. SCHERRER,
28-2t Board of Public Works.

PROPOSALS FOR SEWAGE PUMPING ENGINES.

Office of the Department of Public Works,
Chicago, Ill., July 5, 1892.

Sealed proposals will be received by the city of Chicago until 11 a. m., Monday, July 25, 1892, for the construction, delivery and erection, upon and within the foundations provided by the city of Chicago, of two (2) "sewage pumping engines" and boilers, together with the necessary feed-pumps, pipes, etc., and complete in all details and particulars for constant daily use in connection with the web well and discharge conduit provided by the city of Chicago.

One engine to have a capacity to raise fifteen million U. S. gallons fifteen feet high every twenty-four hours.

One engine to have a capacity to raise twenty-eight million U. S. gallons fifteen feet high every twenty-four hours.

According to plans and specifications on file in the office of the department of public works of said city.

Bids will not be received after the hour above named.

Proposals must be made out upon blanks furnished at said office and be addressed to said department, indorsed "Proposals for Sewage Pumping Engines," and be accompanied with $1,000 in money or a certified check for the same amount on some responsible bank doing business in the city of Chicago and made payable to the order of the commissioner of public works.

The commissioner of public works reserves the right to reject any or all bids.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities together with sufficient pecuniary resources to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names as well as the name of the firm, with their address.

J. FRANK ALDRICH,
28-1t Commissioner of Public Works.

PROPOSALS FOR FOUNDATION WORK—COMPRISING EXCAVATION, PILING, MASONRY, ETC.

Office of the Chicago Public Library,
City Hall, Chicago, June 5, 1892.

Sealed proposals are invited by the board of directors of the Chicago public library for the excavation, piling, masonry, concrete work, etc., inclusive of all material and work required in the construction of the foundation of the Public Library Building on Dearborn park, city of Chicago, as per plans and specifications on file in the office of the superintendent of the board on Dearborn park. Copies of the specifications and plans may be obtained on the order of W. B. Wickersham, Secretary, at the office of Shepley, Rutan & Coolidge, Venetian Building, Chicago. All bids must be addressed to W. B. Wickersham, secretary, at the office of the Chicago public library, in the City Hall, where they will be received until four (4) o'clock p. m. of July nineteenth (19), A. D. 1892, at which time they will be publicly opened by the committee on buildings and grounds of the board of directors of the Chicago public library.

Each bid must contemplate doing all the work and furnishing all the materials called for in the plans and specifications, and must be made upon a printed form furnished at this office. A deposit in cash or by certified check, payable to the order of W. B. Wickersham, Secretary, for three (3) per cent. of the amount of the bid must accompany each bid. Each bidder's deposit will be returned in case the bid is rejected, or if it is accepted, upon his entering into a contract with good and sufficient bond for the faithful performance of the same. Should the bidder to whom the award of the contract is made fail to enter into such contract and furnish such bond within one week from the date of notification that the same are ready for execution, then said deposit shall be forfeited to the board of directors of the Chicago public library.

The right is reserved to reject any and all bids.

By order of the board of directors of the Chicago public library.

W. B. WICKERSHAM.
28-1t Secretary.

NOTICE TO SEWER CONTRACTORS.

Clerk's Office of the Township
of East Orange.

Sealed proposals for the construction of approximately 2,400 feet of 2 ft. 6 in. by 3 ft. 6 in. Brick Drain; 1,000 feet of 2 ft. 9 in. by 3 ft. 9 in. Brick Drain; 700 feet 18-in. pipe; 700 feet 15-in. pipe; with manholes, basins, inlets and appurtenances, addressed to Stephen M. Long, Township Clerk, East Orange, N. J., will b ereceived until 5 o'clock p. m., Monday, July 25, 1892, at the office of the Clerk, Commonwealth Building, East Orange, N. J.

Plans, sections, blanks, and specifications, may be seen after July 8th, at the office of J. J. O'Neill, Township Engineer, Commonwealth Building, East Orange, N. J.

A certified check of $5,000, payable to the Treasurer of East Orange, must accompany each bid.

A bond of 30 per cent. of the contract price will be required from the party to whom the work is awarded, with security to be approved by the Township Committee.

The Township Committee reserve the right to reject any or all bids.

By order of the Township Committee.

STEPHEN M. LONG,
Township Clerk.

J. J. O'NEILL,
Township Engineer.
June 22, 1892. 28-3t

U. S. ENGINEER OFFICE, 537 CONGRESS St., Portland, Me., June 25, 1892.—Sealed proposals for completing construction of stone wharf and for rough stone jetty, at the mouth of Kennebunk River, Me., will be received at this office until 3 p. m. Wednesday, July 13, 1892, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. 28-1t

U. S. ENGINEER OFFICE, 537 CONGRESS St., Portland, Me., June 22, 1892.—Sealed proposals for construction of rip-rap jetty at the mouth of the Saco River, Me., will be received at this office until 3 p. m. on Wednesday, July 13, 1892, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. 28-1t

U. S. ENGINEER OFFICE, 537 CONGRESS St., Portland, Me., June, 22, 1892.—Sealed proposals for dredging at the mouth of the Saco River, Maine, will be received at this office until 3 p. m. on Wednesday, July 13, 1892, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. 28-1t

UNITED STATES ENGINEER OFFICE, Boston, Mass., June 25, 1892.—Sealed proposals, in triplicate, will be received at this office until noon of July 25, 1892, for the delivery of eighteen thousand barrels of American hydraulic cement, at Fort Warren, Boston Harbor, Mass. Attention is invited to the Acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. For full information apply to S. M. MANSFIELD, Lieut. Col. of Engineers. 28-3t

NOTICE TO CONTRACTORS.

Mayor's Office,
Asheville, N. C., June 30, 1892.

Sealed proposals will be received by the Mayor and Joint Board of the City of Asheville, N. C., until 3 o'clock p. m. the 1st day of August, 1892, for furnishing and setting up in the pump house on the Swannanoa River, about four miles from Asheville, one steam-pumping engine and boiler, capacity 1,000,000 gallons in 24 hours. One power pump and water wheel, capacity 750,000 gallons in 24 hours. Also for furnishing and laying about 3 miles of 16 in. water pipe.

Plans can be seen, and specifications obtained at the office of the City Engineer, Asheville, N. C.

C. D. BLANTON, Mayor.
B. M. LEE, City Engineer. 28-4t

NOTICE TO SEWER CONTRACTORS.

City of Springfield, July 5th, 1892.
Office of Superintendent of Sewers,
43 Bridge Street, Springfield, Mass.

Sealed bids indorsed "Proposals for Sewer" will be received by the undersigned until 6 o'clock p. m., July 20, 1892, for the construction of about 3,153 lineal feet of brick sewer in Rowland Ave. and Douglass St.

Plans and specifications may be seen and further information obtained at the office of the City Engineer of said Springfield.

The right is reserved to reject any or all bids.

Per order of the Committee on Sewers and Drains.

WILLIAM L. DICKINSON,
28-2t Superintendent of Sewers.

TOWN OF SOUTHBRIDGE SEWER DEPARTMENT.—Proposals for building town sewer. Sealed proposals for laying 6,000 ft., more or less, of 6, 8, 10, 12 and 14-in. sewer pipe, pipe to be furnished at the trench by the town; or, the furnishing and laying 6,000 ft., more or less, of 6, 8, 10, 12 and 14-in. sewer pipe, according to plans and specifications filed at our office, will be received until 12 o'clock noon, Saturday, July 16, 1892, said work to be done under the supervision of the town engineer, and subject to the approval of the Selectmen. A bond will be required for the faithful performance of the contract. The right to reject any and all bids is reserved. Address all communications to the undersigned: J. M. OLNEY, V. W. LAMENROUX, ALBERT W. MARTIN, Selectmen of Southbridge, Mass.

Southbridge, Mass., June 30, 1892.

SEALED PROPOSALS WILL BE RECEIVED by the undersigned, Committee of the Board of Chosen Freeholders, for the rebuilding of the Clerk's and Surrogate's office. Plans and specifications can be seen at the office of Campbell & DeBaun on and after July 9. Bids will be opened at the Court House on Monday, July 18, 1892, at 2 p. m. The Committee reserves the right to reject any and all bids.

J. L. VAN BUSKIRK,
J. H. OUTWATER,
C. J. TERHUNE,
28-1t Committee.

SEALED PROPOSALS WILL BE RECEIVED by the undersigned, Committee of the Board of Chosen Freeholders, for the building of two stone culverts on Central Ave., Hackensack, until Tuesday, July 12, 1892, at 2 p. m., at the Court House in Hackensack.

Plans and specifications may be seen at No. 169 Main St., Hackensack. Bids for each culvert must be separate. Committee reserves the right to reject any and all bids.

J. L. VAN BUSKIRK,
C. J. TERHUNE,
J. C. VAN SAUN,
28-1t Committee.

TREASURY DEPARTMENT, OFFICE Supervising Architect, Washington, D. C., July, 2, 1892.—Sealed proposals will be received at this office until 2 o'clock p. m. on the 2nd day of August, 1892, and opened immediately thereafter, for all the labor and materials required for the excavation, foundations, cutstone and brick work, iron and wood floor and roof construction, roof covering, approaches, etc., for the U. S. Post Office building at Fort Dodge, Ia., in accordance with the drawings and specifications, copies of which may be had on application at this office or the Office of the Superintendent at Fort Dodge, Ia. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any or all bids and to waive any defect or informality in any bid should it be deemed in the interest of the Government to do so. All proposals received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposal for the Excavation, Foundations, Cutstone and Brick Work, Iron and Wood Floor and Roof Construction, Etc., for the U. S. Post Office Building at Fort Dodge, Ia." and addressed to W. J. EDBROOKE, Supervising Architect. 28-2t